AMATEUR RADIO 1976

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NEW Bicentennial Callsigns!

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NEW FCC Regs Coming!

Restructuring or De-structuring?
Communicator Class Nears!

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NEW Magazine Formats!

Special 73 conversion project for your bookcase

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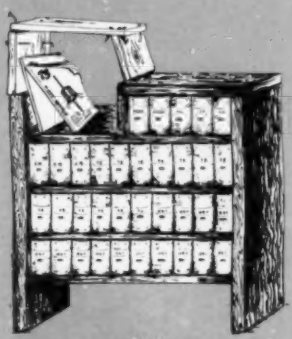

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JANUARY 1976
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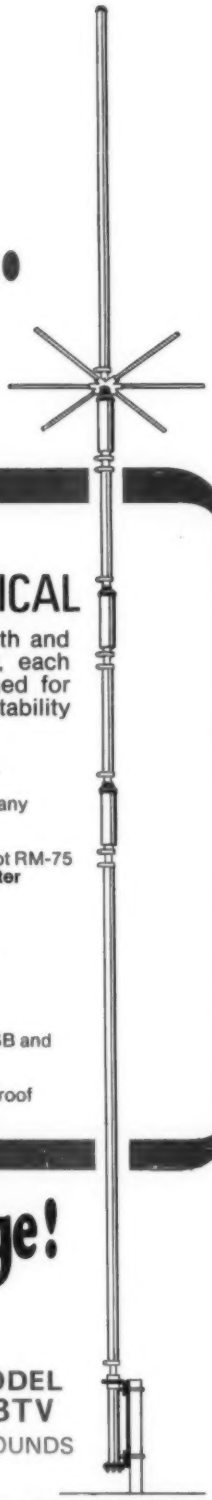

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73 amateur radio

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EDITORIAL BY WAYNE GREEN

THE BIGGER ISSUE

Well, here it is, your first giant sized issue of a ham magazine. You might as well be enthusiastic about it because this is the way it is going to be. To help you convert over we have the bookcase conversion project on the next page . . . thanks to Marsha Kay Gilger for the drawing.

Readers want to know why the large format. A reasonable question.

It all started when *QST* announced that starting with January they were going to go to the large size magazine, citing paper savings as a reason. I cited that as patent nonsense since more paper does not yet cost less, but I have the feeling that no one was paying much attention to me. I get that feeling a lot.

With just one magazine in the new size we might have held the fort, particularly since we tried as hard as we could to think up advantages to the readers in the new size and could come up with nothing. Then *CQ* and *HR* announced they were going large format. Oh, oh . . . this meant that many ads would be made up in the large size. It costs a lot to make up ads and few would be made in two sizes, which left no choice but to be dragged kicking and screaming into the large format.

It will not be news to readers that those advertisers are paying for your magazine . . . the ads pay the printing and paper bill as well as the generous payments to authors for articles. Subscription income pays for keeping records and mailing the issues and not much else. Of course without a lot of subscribers you don't get ads.

Once we decided to go big we figured what the heck, why not do it first? So here we are. Of course we had to cram all the November and December articles in one issue to get 1975 out of the way last month. Even though the last issue was double sized and had two months listed on the cover, it will still only count as one toward subscriptions. Merry Christmas.

NAME CHANGE

Got a letter from WB4SLO, Nenad S. Downing (note the NSD there), claiming to be a *CQ* fan (I knew he was pulling me leg right there) and to be irritated by Wayne Green (you have to be dead from the neck up if I don't get to you). Then he goes on to praise the magazine outrageously . . . the articles and even the beneficence of ads. I can read letters like that all day. But that Nenad S. Downing began to percolate through . . . hmm . . . now, with a small change to Nayne, the middle initial is there already, stands for Sanger . . . I haven't used it much because my father goes by that name . . . and you can see how things perk up through . . . to Nayne S. Dreen. Heh.

The Candy Company seems to be getting closer and closer to making it possible for me to achieve the goal of many years . . . W1NSD. I'm so used to using W2NSD portable that I have an awful time just saying W2NSD when I operate from the Brooklyn shack. When I moved to New Ham Shire thirteen years ago, Candy suggested I hold tight, that rule changes would be along so I could get W1NSD and not have to settle for WA1EJU. Things move slowly in Washington, but one of these days . . . one of these days. . . Then all I'll have to do is wait for Candy to process the application . . . will I live that long? In the meanwhile I'll have to mull over that Nayne S. Dreen bit.

OTTAWA

The Radio Society of Ontario pulled off a first rate hamfest in October, with almost 900 registered in attendance and a nice bunch of exhibits, prizes and talks. The dinner was fantastic . . . 636 banqueted in one enormous room . . . and the food was excellent, quite a surprise to any regular banquet eater . . . roast beef, shrimp, black forest cake, the works. Congratulations are due to the group of hard workers that made it possible.

ARRL ELECTION

One of the California club newsletters had a good deal of info on a contest for Director between Doc Gmelin and Bill Eitel. I hated to see amateurs faced with a choice there as both are fine men . . . Doc has been at the ARRL Director biz for years and knows his way around . . . he is a tremendously likeable bouncy guy with a fantastic sense of humor and a bright inquiring mind.

Bill Eitel, recently retired from Eimac, by far our foremost manufacturer of power tubes for hams, has something that is extremely valuable for the League . . . industry background and knowhow. Bill knows everyone and is liked by everyone . . . he's been an enthusiastic League supporter for what seems like 50 years . . . he's been in the background of many of the better things that the League has done, such as the election of Herbert Hoover, Jr., as President of the League, a feather in the cap for amateur radio.

The ARRL bylaw which prohibits active ham industry people from being considered for elective positions has kept out some very fine men in the past . . . men with a deep interest in promoting amateur radio, not just their products . . . men like Herb Johnson of Atlas (the chap who started Swan!), Andy Andrews of Hy-Gain, etc. Bill Eitel would have made a very valuable Director years ago if the bylaws had permitted it and the League could only have gained from the association.

In this case, whichever way the election goes the ARRL will do well, so it is indeed painful to know that also, whichever way it goes, the ARRL will *lose* a good man.

TOY OR TOOL?

Topic number one, the "restructuring" of amateur radio, has generated a lot of heat . . . not an awful lot of light. Perhaps we can better consider the many possibilities if we go back to basics and start from there rather than trying to fathom the impact of new license classes on our own operations.

There are some fairly well defined guidelines as to the purposes of amateur radio . . . these are set out in not too clear form in 97.1 of the regulations. The rules state that amateur radio is to provide emergency communications, advance the communications art, provide a source of technically skilled people and provide international good will.

While it's true that older folk who get into amateur radio can help with the emergencies and good will, we would be less than honest if we didn't admit that the pool of technically trained people and advancement of the art doesn't refer largely to getting youngsters into amateur radio, not old timers. Thus it would seem to me that there is some logic to having our rules favor attracting young blood.

The proposed Communicator license was the major reason for the whole restructuring bit, so let's just mull over what we might or might not be able to accomplish with such a ticket. As I get the scene, the Communicator license is supposed to be a sort of half way bridge to get CBers into amateur radio. There appear to

be two main reasons for wanting CBers in amateur radio . . . hams feel a need for the hobby to grow and just don't know where else to turn for blood . . . and industry sees billions of dollars of sales if CBers can be encouraged to move to a new band or two. I'm afraid that the latter is more the moving excuse for what has happened so far.

Which brings me to a rather basic question . . . will we find in CBers this large group of teenagers that are what we need for amateur radio? My experiences on CB are certainly not encouraging in this direction.

The records show that roughly half of the newly licensed amateurs are either 15 or 16 years old, too young to get CB licenses. It looks to me as if we're planning on fishing in the wrong lake for the trout we want. I think that the ham clubs are on the right track . . . they're out there beating the bushes in the high schools for prospective hams, not flagging down truckers.

If we're out to find matured voices to fill up our empty repeaters, then Communicatorizing CBers is a good answer. If we want to really get growth . . . to bring some real money into ham manufacturing instead of keeping it almost as a hobby as it is today . . . the CBers are the way to go. Who knows, the ham manufacturers might get powerful enough to get a voice in the EIA and then we might be able to throw off the FCC entirely as the CBers have.

Amateur radio has a long history of inventing and pioneering and I think we all want to keep this alive . . . all we have to do is be sure of how to do it and make our voice heard above the tinkle of the coins in the till. I think that the ham clubs with good working license classes are going in the right direction . . . and I'm not convinced that a rubber stamp ham ticket is right, even though it could mean billions of dollars to industry.

CB IN PERSPECTIVE

Putting down CB is in many cases more an indication of insecurity on our part than anything else. CB has changed a lot in the last couple of years. The sunspots have died down and there is little DXing these days . . . a factor which has taken the steam out of super high power stations. The laws against amplifiers are beginning to be felt too . . . they are quite difficult to get in many areas.

With the enormous influx of trucks on the CB channels and the reduction in DXing, things have calmed down a lot. Bad language is the exception in most areas . . . it's a lot different talking to someone a thousand miles away and a neighbor.

It is time to give CB its due . . . amateur radio can't come close to CB as far as keeping track of traffic conditions. If you want to be able to avoid tieups you will be listening to channel 19, not your local repeater. If you come across an accident and want to call the police you may be able to do it through the repeater . . . but chances are you'll get excellent service on CB via a nearby base station. The CBer has the advantage of being nearby, not 25 miles away in another town, like the repeater. Argue with me, if you like, but if we really want to help in emergencies we need both amateur radio and CB in our cars, then we can pick the best one for the problem at hand.

Perhaps it is time to accept CB for what it is today, a relatively effective communications medium for anyone with a hundred dollars to spare. Considering that it is just about totally without rule enforcement, it is doing amazingly well. I wouldn't be without a pair of ears on channel 19 on any long trip myself.

COMMISSIONER LEE SPEAKS

Thanks KØBIY for the newspaper clipping quoting FCC Commissioner Lee as saying that he thought the best solution to the CB problem was no regulation at all . . . "I lean towards saying, 'Let's forget them.' " Lee pointed out that the actual enforcement of the regulations is miniscule. "About half a dozen" violators of CB regulations have been fined in the last year. "They're hard to catch, and when we catch them the Department of Justice doesn't want to prosecute."

ASPEN?

Hey . . . do you like to ski? How'd you like to get together with a bunch of us in January for some skiing . . . some fantastic meals . . . and a whole lot of ham talk?

About ten years ago I got conned into learning to ski. That turned out to be one of the better things that has happened to me in this lifetime . . . I've enjoyed skiing much more than I could ever tell you. After a few weeks of thrashing about on one of the local mountains, Kayla Bloom WØHJL, of Denver, talked me into stopping off in Colorado for a week at Aspen. In addition to getting to know Kayla and as a result signing her on to be editor of *73*, I found three things which just about blew my mind . . . the skiing at Aspen, the ski instruction at Aspen, and the amazing restaurants.

I arrived there an utter novice skier. Within one week they had me plunging down their most expert trails and ready to fearlessly tackle just about anything. They seem to have somehow managed to corner the world market on expert ski instructors. Since that time I've been out there twice more and both times my skiing improved tremendously.

With four big mountains to ski, they have something for everyone. I've skied most of the trails, but my preference is Buttermilk and Tiehack mountains. It seems to snow a few inches every night, resulting in beautiful powder for the early risers.

Restaurants. I think there are more superb restaurants in Aspen than any other single town I've visited . . . including New York. For instance, there may be one or two Mexican restaurants in San Antonio to rival Aspen, but not in New York.

On many weekends last winter groups of skiing hams would attack the mountains of New Hampshire, HTs at the ready. It's a lot of fun mixing the two interests. We would keep in touch with each other as we went up and down the lifts and slopes, usually on 52 direct. When some of the fellows went to other ski areas we would work them through a repeater and keep in touch.

It looks as if at least five or six of us from the Boston area will be flying out to Aspen, HTs in hand, for a week of skiing . . . January 3-10th. We'll be having a great time. Some are good skiers, some are just beginners. Steve Murray K1KEC, one of the New England repeater coordinators, just got on skis last winter for the first time . . . he'll be there. Chuck Martin WA1KPS, the chap who runs Tufts Radio, the largest ham dealer in New England, will be there. Chuck had done quite a bit of cross country skiing, but just got started on downhill last season . . . and he's a terror already. Two nicer guys you'll never meet.

Chuck threatened to bring a repeater, but Aspen is so small that it wouldn't be of any real use. We'll do fine with 52 direct there.

If you'd like to come along and join the fun . . . ski with us . . . get around

Continued on page 32

be my guest

visiting views from around the world

Son of a Gun! The Noble Breed!

It was raining last week and in seeking shelter we ran across one of the local QRPers. There was that lost expression on his face. "I am worried," he said. "I know that Glorioso is coming up and I need that one and Juan de Nova is on right now and I need that one. I worry about them every night and I am losing sleep over them. It is really a problem. A real problem."

We thought about this for a moment and took a chance at the reassurance angle. "You will work them," we promised the QRPer. "Sooner or later you will work them. That's for sure!"

The QRPer did think about this for a bit but was right back. "But when?" he asked. "When will I work them? And after I work them, what about those new countries that are sure to come? How do I know I will be able to catch them? How can I keep from worrying about those ones? You must see the problems I have, don't you?"

Son of a Gun!! What could we say? For there is a joy in anxiety and solace in worry. And for some there will never be a happy day without its worry. For when you have worked everything, what will there be to look forward to?

* * * * *

We were doing some road work over the ridges last week, getting set for the CQ WW DX Test. And we ran into one of the locals who has toiled these many years on various things such as traffic nets, rag chew nets, state-of-the-art things and stuff like that. "How's DX?" this one asked politely, and we had to admit that it was thriving. "What are you working these days?" he asked, and we had to admit that we were working the world every morning and evening. "Anything new?" he persisted, and we had to admit that after working everything we were now working everything backwards and with our left foot as an added challenge.

The Ordinary One thought about this for awhile and finally came back with a bit more. "You know something?" he said. "A few years back I went to the Pacific Division meeting and one of the fellows there said that DXers were the top of the amateur crop . . . and that they knew it. I really think that he was right. I really do."

Son of a Gun, what could one say to something like that – though one must expect such things. When you are Number One . . . when you stand like an unattainable model to those other types, one must realize that DXers are unique. So all we could say was, "Heck, I always thought that everyone knew that already."

DXers are the Noble Breed!! Would any true-blue one admit otherwise?

Reprinted from the West Coast DX Bulletin.

A Good Deal for Dummies

Early one morning I was watching the tube. They had a program on telling about communities who got Federal money and some good action by banding together and legislating what they needed.

I got to wondering if we hams couldn't do something like that. No big national organization was telling these communities what they needed. The ideas came from the people who were going to be affected by the changes.

The program told about a beautiful wooded area which was just sitting there. It was owned in the main by people outside the area. Somebody got the idea that, since the town was growing a bit, the woods would make a nice park. Soon other people became interested. They got together and made a plan. Then they talked to the land owners and got their consent. Next they got the plan approved by the community government. And, what do you know? They got the park plus some Federal money to spend for roads, picnic tables, swings and things.

Okay, we hams have a natural resource sitting there. It's owned by everybody. We would like to park there now and then. We find it a nice place to come and visit. Maybe it's 80 meter CW, 160 phone or 2 meter teletype, or maybe even 440 fast scan TV.

A long time ago someone got the idea that these are really fine natural resources, and, fortunately, some of the good spots got reserved for those who took the trouble to equip themselves to use them.

Now and again hoodlums come along and garbage up those beautiful spots, but nature has a forgiving way about her, and the spots are clean again for the next batch of humans.

Here is where we ought to shake ourselves out of our lethargy. Right now, instead of being lucky people, we hams are getting the business. Instead of getting Federal money to beautify our part of the natural resource, our leaders are about to call in the Feds to cram us into smaller segments, compartmentalize us, and dump garbage all over us. And many of us dummies think we're getting a good deal.

Paul L. Schmidt W9IDP
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Bloomfield IN 47424

MORE on next page

Called to (Vari)arms

Mementos of Solomon Islands days.

In 1940, Henry Rice W9YZH, in St. Louis, designed a variable frequency oscillator, which James Millen Co. put on the market commercially as the Variarm. During WW II, an enlistee named Harry Turner W9YZE, from the same metropolitan area, loaded up a Variarm and went to serve Uncle Sam in the Solomon Islands.

Harry was — is — a telegrapher of note, and presently got his go at winning the war with his skills.

It seems Harry and his gang occupied one end of an island while the Japanese camped at the other end. Somewhere in the vicinity lived an assortment of headhunters and a missionary.

The Japanese gave trouble by night, wherefore Harry's gang felt constrained to call in the bombers for a little softening action. The process involved getting on the radio and calling for help. The Japanese, being largely educated at UCLA, as the saying goes, weren't ignorant of our communications, and, hearing same, would immediately join in the transmission with spurious signals of their own ("jamming").

That's where the Variarm and Harry's "fist" came in. He'd attach an antenna directly to the output of the Variarm and start pounding his key. He could put on a good show, too: He'd been clocked in training at 35 wpm on a straight key. The Japs, sure they'd found the hot line, began their jamming, and Harry started pulling down that Variarm to change the frequency gradually. The Japanese credulously followed the drifting, seemingly unstable rig to the limits of its variable arm's play. At that point, Harry would punch the operator next to him, who would use the original frequency to call for help. Wonder just what the Japanese thought next day when they were on the receiving end of U.S. bombs?

To regress just a moment, going back to Harry's CW proficiency: In 1964, Harry applied to the Signal Corps for some certification of his code speed record and got it. When in 1966 the Red Chinese claimed a girl of theirs had set a world record at 30 wpm, Harry trotted out his certificate. The Chinese claim was based on a "secret" speed run, excused as being so to avoid distracting disturbances that could have upset her concentration. Did it even take place? Who knows, but Harry's feat was not only a matter of government record, but personally witnessed by a roomful of onlookers, including the commanding general, Ben Lear. Harry says he handled code under "business" conditions and learned to concentrate accordingly.

Harry Turner was released from the Army in 1945. The Egyptian Radio Club (W9AIU) had been founded in 1929 and wasn't unknown before Harry's influence began to show in 1950; ERC had won the ARRL's Field Day contest three years in a row, 1937-39. Harry was soon elected treasurer of the Granite City, Ill., club and has held that post ever since. He's retired now from his variety of livings, having been railroad telegrapher and printer as well as having worked for 23 years in a paper mill. For a time he was editor-secretary-treasurer of the QRK low power radio club. Today he's usually around the club's 16-76 repeater, and every Thursday night sees him at the clubhouse by the Mississippi's Chain of Rocks Canal.

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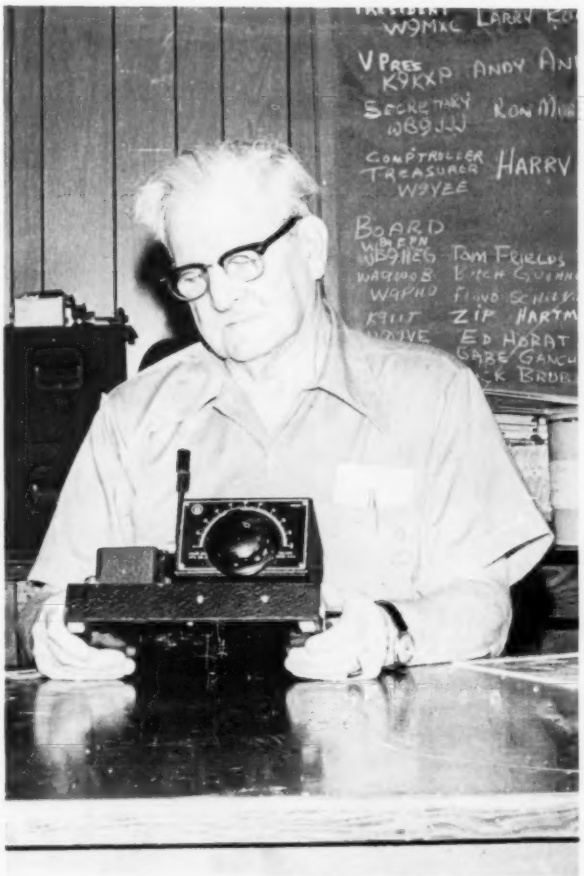


Harry Turner W9YZE looks over the Millen Variarm VFO, like the one with which he decoyed Japanese in WW II. The rod sticking up is the "variarm" that turned the trick on this rig, with Harry providing the "fist."

What This Country Does Not Need

The eternal problem of acronyms is that they are great if you recognize them, but confusing when you do not. OTP stands for the Office of Telecommunications Policy, a White House Office – some feel it's another FCC . . . potentially.

The head of the OTP was asking the House Appropriations Committee recently for an increase in its budget, it being noted that the OTP is currently a "way station" to a comprehensive federal agency handling communications matters in the future. However, it was acknowledged that the time was not ripe for a stronger office outside the Executive Office of the President. OTP was asking for $8.9 million to run the 48-man office for the next year. The FCC got a much stronger going-over when it came up to discuss its budget, asking for $49.8 to run that agency in the coming fiscal year. The OTP has been heard in the past urging the FCC to faster action for the CB Service. As one astute observer has said: "What this country does not need is two FCCs . . . or maybe even one OTP!!"

A recent item in the newspapers called attention to a manpower crisis in radio spectrum management. John Eger, Acting Director of the Office of Telecommunications Policy, declared a "state of emergency" and announced a government-wide career development program to rectify the situation.

With the next international general frequency conference scheduled for 1979, worldwide allocations will be established through the year 2000 – and there lies the problem. Assignments of spectrum space are negotiated at these international meetings and the resulting agreements supercede national law. According to a study made at OTP's request, more than 57 per cent of the U.S. agencies' experienced and conference-tested negotiators will have retired by 1979 – leaving only 15 top-level experts to represent the United States. The study found that of the 194 individuals now involved in national-level agency activities for spectrum management, only 35 are principal managers with the negotiation, regulatory compliance, technical analysis and decision-making experience bearing on radio frequency management. Of that number, 20 are expected to retire before 1979.

According to a General Accounting Office report, such an impending personnel shortage could jeopardize the U.S. interests at the most critical international radio conference in 20 years, and could spell trouble for future users of the radio frequency spectrum.

For that reason the OTP has instituted the first government-wide career development program for the training and retention of the highly specialized personnel needed in spectrum management. "National and international concern mounts over the continued availability of spectrum space," the OTP said. "To respond to that concern it is necessary that an adequate investment be made in personnel development."

Reprinted from the West Coast DX Bulletin.

Jim Huffman's

What will be happening in amateur circles in January, 1986? We asked Hufco's WA7SCB, and here are his predictions:

The next ten years for amateur radio (and electronics in general) look to be the greatest ten years ever conceived by man. Improvements should come in two main areas to amateur radio: operations and equipment. As far as operating goes we foresee more and more hams joining the fraternity. Face it: The world is smarter nowadays and promises to be even smarter in the future. People in general are becoming more technically oriented. No one today hasn't at least heard of the computer, and most deal with computers every day. We even communicate with computers to pay our bills. This technological "brainwashing" of all mankind should prove to lessen people's fear of amateur radio. Twisting knobs, using a microphone, watching meters, and so on, are the so-called fears of amateur radio, but none poses as much of a psychological problem for the average man as it has in years gone by. And in ten years! All mankind will be ready to accept the possibility of communicating around the world via amateur radio.

The technological boom has also primed man's "escape" mechanism. He travels, he plays, he turns to drugs, all supposedly as his escape from the hard, cold technical world. And what better escape than amateur radio? Electric bills will never climb proportionately to gasoline bills. The average man can travel the world and never leave his cluster house, or condominium. Amateur radio offers him everything: the excitement of the DX contest, the enjoyment of the ragchew, or the unequalled pleasure of home construction. All this in ten years if we now realize the potential and spread the word that amateur radio is the greatest!

As far as pure technological advances in amateur radio go, look for computer controlled repeaters in the not too distant future. Look for computer controlled hamshacks next. Scanners that find an empty "slot" on the band. And new narrow bandwidth modulation systems that promise more hams per megacycle.

There are indeed paradoxes which will appear in the future. One involves complexity (sophistication) and lower cost; the other is complexity and simplicity. While one usually thinks of the more complex devices costing more, we are witnessing the opposite. More complex functions are being integrated to a simple chip and then mass produced, so that they cost less. And costs are going to have to go down in other ways (proportionately, of course, we will still have terrible inflation). Manufacturers will have to solve high labor costs to lower the prices proportionately, and manufacturers will! People should wise up in ten years, and start producing more. Look for per piece wages rather than hourly pay. A lot of people are using this already. The lazy worker earns a

be my guest

visiting views from around the world

Here to Stay

It doesn't hurt once in awhile to do your own thinking. I was listening to an on-the-air round table discussion of the FCC Proposed Rule Making Docket No. 20282.

There seemed to be two types of comments. One type came from ARRL loyalists who thought we should go along with the proposals as modified by ARRL management. Then came the comments from the die-hard, independent thinkers who inquired into the reasons for wanting the changes made.

The reasons for the changes seem obscure. If the proposed changes are for operator skill upgrading, certainly the existing five classes of licenses offer a reasonably wide spectrum.

If the reasons for these changes are for opening up one more class, the codeless class, we certainly don't need all this mountain of paper just for that.

So just why are we undergoing this massive rule making exercise? I'm wondering why not to stir up the troops, but rather to inject the question, "Why?" Change is fine if it's necessary, but what is really necessary about the proposed changes?

We are still, when the dust clears, going to plug in on the power line or battery, hook something to an antenna for the purpose of poking out a signal and hoping to get one back. We want to modulate that signal by some scheme (exotic, sophisticated, or otherwise). We're still going to be the same clever (or dumb) human beings at opposite ends, doing it all for the pleasure we get out of it. That part of it won't change, I hope.

So what is changing? Really, what does Docket 20282 gain for us? We are going through a huge paper exercise for a net gain of promises. Maybe we'll get a new 10 MHz segment — maybe. Plus we'll get some new guys who claim they CAN'T learn the code.

It was reported recently that doctors are getting disenchanted with the American Medical Association, the AMA, because it's too costly for what they get, and they don't look to it for leadership any more.

I belong to the ARRL. I support it where I can, but I'm disenchanted with some of the direction the ARRL gives. These thoughts might point the way to some changes not so much to the FCC Rules, but to the direction we are being led.

CW is outmoded. Who wants it? Okay, think that way. Maybe it doesn't happen very often, but once in a great while knowledge of CW turns out to be of great help.

If I were in trouble a long way from home, I'd surely try a CW contact on one of the Novice bands. The guy on the other end might be just a kid, and his CW might be slow, but I'd trust him to get my message.

No, we don't *need* to know CW once we pass the test (except at license renewal time), and I don't care if the FCC wants to grant licenses to those who CAN'T learn the code. But I don't wish to abandon CW. It's like another language. I want to keep it alive.

CW transmitters are the easiest to build and to operate. Before the advent of SSB they were the most efficient in miles per Watt.

We have tremendously sophisticated methods of communication nowadays: tropo-scatter, satellite, microwave, computers talking to computers, scramblers, high-density multiplex, and much more. In spite of it all, CW is here to stay. Our "friends" across the seas seem quite sold on it.

Paul L. Schmidt W9IDP
PO Box 105
Bloomfield IN 47424

1986

lazy man's wage; the hard worker has no limit to his pay.

Paradox number two is even easier to see. Complexity vs. simplicity. While on the one hand things are getting more complex, they are getting simpler, too. Already the average ham can put together systems of sub-kits into his own custom designed equipment. Witness the kits from VHF Engineering, the International Crystal kits, our own digital kits. In ten years it will get even easier. And while digital subsystems are easier to interconnect now, look to the time when it will be just as easy to fabricate your own complex analog systems, like a sideband rig. The complexity of the rig will be a function of your basic knowledge and how much you want to spend. With all the complexity you can design in, the designing itself and the operation of the finished product will become simpler. It will be much easier to use a computer autotuned rig that automatically matches any piece of wire on any band and tunes itself to optimum at the flick of a bandswitch. And that is what I foresee in the next decade. Our present day broadband rigs with their inherent compromise designs will give way to computer tuned rigs that have the same one hand operation with far improved performance.

The next decade promises excitement, adventure, and challenge. I guarantee that, no matter what happens, we will all rise to meet the occasion. So start to stand up now. Learn about logic, computers, analog, design, and so on. Although you may only be able to possess a cursory knowledge of such a broad range of matters, that cursory knowledge will allow you to interface some powerful subsystems in the "simplicity" of the next decade!

Jim Huffman WA7SCB
TWS Labs/Hufco
Provo UT

ou goons don't ever proofr
lousy
bunch of rocks
you ignored my comments in
I insist that you print ev

LETTERS

A NATURAL

A recent article submission to Wayne written by me was rejected (so don't quit writing if you are rejected), but his always appreciated comments have prompted this open letter to you – the VHF-UHF ham.

One of my suggestions in the article concerning more effective use of our higher bands was the use of voluntary channels. *Note*, I said totally voluntary. My suggestion was to use the following frequencies as listening posts, so that any activity whatever in the nature of an opening would not go unnoticed, much like the use of beacons: 50.125 MHz, 145.125 MHz, 220.125 MHz, 432.125 MHz, and 1296.125 MHz. There is no magic choice about the frequencies, and I will gladly listen to any and all contrary suggestions. It is just that the .125 remains the same on all bands, the MHz portion is in a part out of the CW and General only areas (so more should be able to use them), and (lastly) their proper use would also be a must.

Even if you hear no signals, try a call on these frequencies. If everyone could monitor the same place (as I do on 50.125 MHz), he could go ahead and work on the bench, etc., and monitor just like FM. If you do find action on .125, move up 5 to .130 and leave the .125 open again. When one first listens he will tune around a little, so he will still hear you. The next guys go to .135, etc. On CW or SSB this is plenty of spacing, and has led to much activity here in the Midwest that I'm sure I would have missed. About 15 of us have tried it for over a year now, and the activity *and* gentleman's agreement to move have worked out quite well. With groups like Smirk increasing VHF activity, a common looking place seems to be a natural to increase activity even more. Comments anyone?

David J. Brown W9CGI
RR5 Box 39
Noblesville IN 46060

PEA-SIZED

I have been racking my pea-sized brain for many years and have nearly short circuited every brain cell that I have (there are only three left, I think) in a futile effort to break the 1 wpm CW barrier. It breaks my heart to part with these hard earned dollars but I will make a sacrifice and ask you to please send me a complete set of those revolutionary code tapes for $14.95, and please hurry before I short out those last three brain cells.

Oh yes, seeing as how I have been stumbling through all that technical jargon for years and years with the only result being a shorted out pair of ears, you had better send me a copy of the General Class study guide too, so that I can reserve one of my three brain cells for the technical bit. You will find one American Express compny money order to cover the whole smear. You see, I am so short on brain cells now that I can't even spell "company" correctly so please send the stuff fast before I completely short circuit and go up in a puff of smoke in an effort to duplicate the original "smoke test."

Richard J. Molby
Armed Forces Writers League
579th Ordnance Company
APO NY 09035

ENDURING

As life member no. 5 of your *73 Magazine*, I thought that you might be interested in a barn I came across here in Conn. I'm not sure if the farmer feels that he can endure the year 73 or the magazine.

Richard Johnston K1QJD
Simsbury CT

BACKGROUND

Just received my first issue of *73* (October), and would like to say how much I enjoyed it. I hadn't really seen the magazine before, as it isn't carried on any newsstands around here and the libraries don't get it. I subscribed on impulse and am glad I did. The format and content beat *CQ* and *QST*; the tone of the articles is sprightly and good-humored, yet informative. I commend you.

For those of us who haven't been reading for years, how about a little background info? Is the W. Sanger Green who does Ancient Aviator your father or some other relative? I found it quite enjoyable. Also, during the past few years, as I read the other ham publications, I ran across rather disparaging remarks about you and your publication(s). I am ordering a packet of back issues, but how about a retrospective look at whatever all that was about from your point of view, again for those of us who are new to the *73* circle?

Your comments and stand on advertisers who do not deliver as promised are a good thing and sorely needed. I've had trouble in that area myself, with hi-fi gear. Back in 1971 I ordered a tape deck from DEFA Electronics in New York, and it was only through the intervention of the New York State Attorney General's office and finally the Federal Trade Commission that they finally sent me a refund check just two weeks ago. (It hasn't cleared yet.) So keep up the good work in this area. As a helpful hint, let Wes Larsen (WN3ZHT), who wrote you about Trigger in the October issue, know that going to the Post Office to complain of mail fraud is a waste of time. The Postal Inspection Service does next to nothing about such things. Tell him to write the Consumer Protection Division of the Illinois State Attorney General's office and the Federal Trade Commission. Those agencies will try to *do* something, usually, while the USPS will send you a form letter stating that they don't think the mail fraud statutes were violated. I believe these laws are so peculiarly worded that most cases of what *we* would call fraud (failure to deliver, no refunds, shipping wrong items, etc.) are not included. The USPS, in conjunction with the Federal Trade Commission, did propose to broaden their protective stance (see *Federal Register*, March 8, 1974) but I don't know whether that ever was implemented.

Anyhow, glad to be in your group now.

William G. Martin
St. Louis MO

Thanks, William, for your letter. The Aviator series is being written by my father and seems to be very popular. Re the anti-73/WG stuff elsewhere . . . several factors are involved. If 73 was a failure they would ignore it, but it has been very difficult for

them to see 73 becoming the largest ham magazine, with the most ads, the most articles, etc. After some two generations as The Establishment, QST is taking it very hard. My outspoken editorials have not cemented friendships . . . the fact is that I have many admirers who appreciate my seeming radical viewpoint and many enemies who fear and resist the changes I bring about. My basic philosophy is that amateur radio is fun! *One of the results of this fun, if it is not ham-strung (pardon), is a wealth of inventions, pioneering and new ideas. Even with the severe restrictions presently in force, which I would like to see removed, virtually every major breakthrough in modern communications has originated with amateur radio. While I am not at all sure what a man can do in this world to be worthy of the privilege of having lived, I have chosen the role of trying to help, in what small way I can, the rolling forward of progress via ham radio. Via 73 I try to encourage new developments, the growth of amateur radio in small countries, etc. My critics say I'm trying to make money from amateur radio, while those around me complain that I am ignoring the money end and getting into trouble as a result . . . witness the IRS problems. I don't know if that explains anything . . . and thanks for the word on dealing with frauds — Wayne.*

BLACKSMITH TYPES

Just want to let you know that I enjoyed your Oct. 1975 issue very much. This issue was right up my alley, since I am not interested in VHF, repeaters, or any other phase of ham radio other than building. The articles in this issue are very desirable for us blacksmith types who aren't happy unless we can get dope on building something new. Sure would like to see a couple or three issues each year for us screwdriver mechanics. Also, how about another super jumbo king size surplus edition each year?

R. F. Herbig W6ME
Oceanside CA

YASME

The YASME Foundation is active again and is sponsoring once more the world-wide DXpedition of Lloyd (W6KG) and Iris (W6DOD) Colvin. The Colvins have already operated under 50 different calls and are now trying for 100. First stop will be VR1Z (15 Dec 1975) and then VR8B (1 Jan 1976). The latter call will count as a brand new DXCC country. Transmitting frequencies are:

CW: 3505, 7005, 14050, 21050, 28050. (Listening up 5 kHz or just inside General Class band.)

Phone: 3795, 7095, 14195, 21255, 28550. (Listening up 5 kHz or just inside General Class band.)

Donations to YASME (tax deductible) are requested but not required.

Lloyd Colvin W6KG
Iris Colvin W6DOD
PO Box 2025
Castro Valley CA 94546

LESS INTIMIDATED

Just had to comment on Wm. Browning's article on logic circuits. AND, NAND, OR, NOR, etc., have stumped me for quite awhile. Now, however, I feel at least a little less afraid of them — or should I say intimidated by them. Thanks much.

J. Hutchinson
Verona NJ

THE SALEM 50

Here are a couple of photos taken on opening night of the Novice course sponsored by the Salem Civil Defense Communications Team at Salem (NH) High School. The instructors are WA1HWE, WA1OAQ and W1PFA.

The total number taking the course is 50, with two or three people from one family in several cases.

Bill Loeffler W1PFA
Salem NH

GETTING OUT

I sent for tapes and a subscription to *73 Mag* **a month ago!** The tapes have been here OK — but no mag. I requested a current issue. Nothing has come. I do *not* need the mag now as I cannot get up to 13 wpm — so I can't pass the General. Since I only wanted to use voice, I am getting out of the whole thing. No more trying for me.

So — please cancel my subscription — immediately — and *return my $8.00* sent to you on Aug. 21, 1975. Thank you.

Fred Lichtgarn
Santa Barbara CA

It may be difficult to believe, but it takes about six weeks for a new subscription to get into a computer, be printed out, and sent to the printer for mailing . . . get mailed and reach a subscriber. We are working on shortening this . . . with our own computer . . . but that is a big deal . . . about $75,000 . . . it will take a few more months to get set up.

I have canceled your subscription . . . there is no way to stop an issue or two of the magazine going to you . . . my compliments . . .

Now, regarding your ham license . . . I am truly ashamed of you. I see little girls of ten getting their General licenses and here you are trying to tell me that a ten year old girl is better at sticking to something than you are.

Your letter is going to get a lot of use . . . I intend to hold it up as an excellent example of why it is important to have a code test for the license. If someone cares so little about getting a ham ticket that they won't even spend that little effort, there is no way that they can be worth anything to us.

It doesn't take brains to get a ham license . . . it doesn't take education . . . it doesn't take any talent . . . all it takes is some work and you are too lazy. We have hams who are so dumb they can just barely talk . . . so uneducated they can't write much more than their name . . . but they hang in there and get their ticket even if it takes them a year of hard work.

You only wanted to use voice . . .

well, that's about all I've used over the years, but there have been times when it has been important for me to know the code . . . it saved 85 lives once, believe it or not. Including mine.

Maybe I'm being harsh, but you sound suited to what I am hearing on CB where it takes nothing more than a reach in the pocketbook to get on the air and waste your time . . . and wait for death to eventually come along, having added little to the world. — Wayne.

LIKE NBC

Here is some information regarding continuing PR efforts in our area. I hope the information will be of interest to other hams, not only in regard to PR, but also in the use of microprocessors and terminals for support of their amateur activities.

Solid 2 meter communications combined with the world of computer technology to provide communications for the State Sanctioned Canoe Races at Milford, Michigan. Race progress from various checkpoint stations along the Huron River were relayed to Race Control via WR8AAA.

Race operations were tightly controlled by the base station in order to cut down on unnecessary transmissions as pertinent race information was being patched to the P.A. System.

Also, located at the base station was a computer video terminal which, combined with remote monitors, was used to format and display race progress to the spectators.

Thirteen members of the Milford Amateur Radio Club participated in the event through the courtesy of WR8AAA. The home brew video terminal was provided by W8JWQ, who normally uses it with an 8008 microprocessor system.

W8JWQ typing race information into his home brew video terminal during the Milford Canoe Races.

Response to the overall effort was very favorable, with many PR points being scored with city officials. For example, witness the following excerpt from the *Milford Times*: "Allen extends his thanks to the Milford Amateur Radio Club for providing superior communications services during the entire two day event. One racer said the local group's services were 'like those of NBC'."

John Moore W8JWQ
Milford MI

FREE PLEASURE

"FREE — one trip to Hawaii for 10 days." (One year from now it's just a memory.)

"FREE — a ticket to the Metropolitan Opera." (One year from now just a musical memory.)

"FREE — one year's subscription to *73*." (Send 3 year subscription and pay for two and get a free year of constant ham pleasure.)

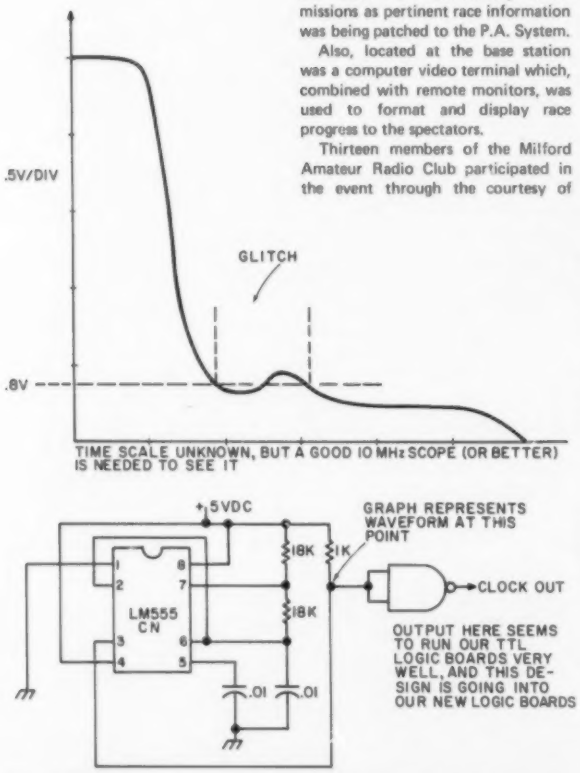
Enclosed please find my renewal and subscription for three years to *73*.

Syd Tymeson W3FL, WA1BXD
Takoma Park MD

GLITCH

We (at Collimation, Inc.) have found an interesting item you may wish to pass on to your readers of *73*. It seems that the 555 timers from National, Signetics and Raytheon (and perhaps others) have a glitch on the falling edge at about .8 V, which may cause some TTL devices to see two clock pulses where only one was intended. I have enclosed a diagram depicting the problem and the solution we use.

Joe Magee WA5ACA
Austin TX


.5V/DIV
GLITCH
.8V
TIME SCALE UNKNOWN, BUT A GOOD 10 MHz SCOPE (OR BETTER) IS NEEDED TO SEE IT
+5VDC
GRAPH REPRESENTS WAVEFORM AT THIS POINT
18K
1K
18K
LM555 CN
CLOCK OUT
OUTPUT HERE SEEMS TO RUN OUR TTL LOGIC BOARDS VERY WELL, AND THIS DESIGN IS GOING INTO OUR NEW LOGIC BOARDS
.01
.01

LM555 clock glitch and corrective circuit. .8 V represents the lower boundary of the uncertainty area for TTL logic signals. A signal which hovers about that point may very easily cause several transitions in a TTL gate. 74174s seem most prone.

GREEN'S FAULT

Keep up the good work in *73*. I'm having a tough battle with the ARRL conservatives down here in Houston, Tex. According to them, "It's all Wayne Green's fault."

I wonder if all the repeater boys know who it was that made the 2 meter band what it is.

Herbert G. Robinson K5URX
League City TX

CRAZY TAPE

I just got word that I finally passed the code test to get my Advanced license and upgrade from a Technician. Since I just graduated from Purdue in Electrical Engineering, passing the written exams was a snap, but the code was a real snag. I got your 14 wpm backbreaker last spring, after I had already flunked the code once. So, once I got the tape and read how great it was, I figured that all I would have to do is listen to it and breeze through. Much to my surprise, I proceeded to flunk the test twice in six weeks. I was pretty frustrated, and just hung the whole thing up for the summer. I got the bug again towards the end of August, and I finally discovered how to use the crazy tape. I found out that I not only had to copy the tape, but copy it *easily*, almost unconsciously, for 20-30 minutes at a time. When I got so that I could talk to my wife and still copy easily, I knew I was ready. I went into the exam room and copied about two minutes of the tape, corrected a couple of mistakes and copied the last two minutes correctly. The difference was how hard I worked on the tape beforehand.

I'll be in Africa next year, and hope to see you all in the pileups!!

Joe Ely WB9PVL
Lafayette IN

WHITE ELEPHANT

Your editorial musings about timers sent me to my new copy of Part 97 to do some checking, and sure enough, there is no legal requirement for a timer on either the input or the output of the repeater. Part 97.88d does say that there must be a timer on the CONTROL SYSTEM so that in the event of failure the repeater is taken off the air. Where this great misconception got started I do not know. I am a control station with one of the busiest repeaters in the New York City area, WR2ACD, an open machine with a weekly user list of about 500-600 steady people. With the transients it goes to about 650 a week. In this case, with the repeater on the air 24 hours a day and getting steady use for about 22 of those hours, a timer is needed to keep rag chewers at bay during "traffic hours," those hours when the commuters take over. At other times, however, rag chewing is usually the mode of operation, and in this case, the timer becomes a white elephant.

As I travel throughout the area I am amazed at the number of machines that have timers and, frequently, not many users. Again, I suspect the great misconception. It is certainly an unnecessary inconvenience. Man does not talk in two to three minute segments with a three second pause. It is needed on the machines with large populations, but why with the less populated machines? Having dispelled the "because it's law" myth, maybe more repeater owner/operators will reconsider their stand on the issue. I think it would make operating a bit more natural. Of course the timer on the control system, be it wireline or 220 MHz and above, must remain in force to keep the uncontrolled repeater off the air.

Stephen Mendelsohn
Control Station of
WR2ACD/WR2AFE/WR2AEH
Licensee of WR2AFS/WR2AEN
Flushing NY

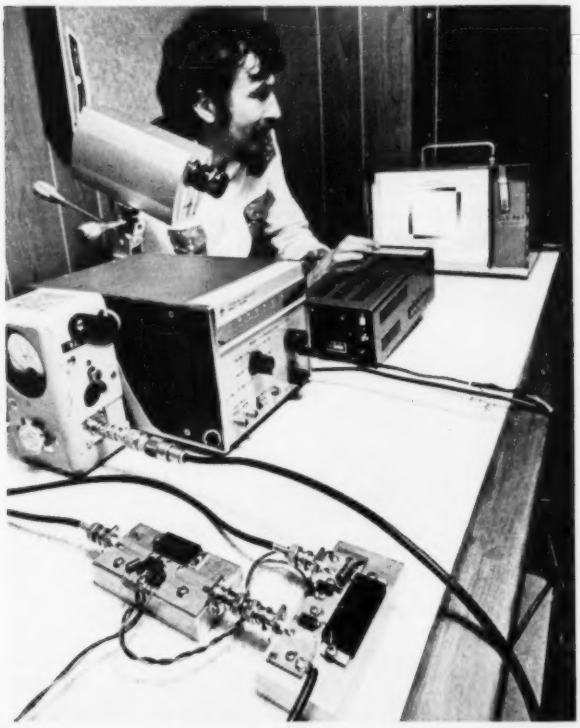
MSI

As a subscriber to your wonderful mag, I would like to tell your readers about a possible channel of amateur publicity.

For the Amateur Radio Club looking for a new Public Relations medium, I have one to suggest. The medium is the MSI program found on many CATV systems. MSI is a mechanized presentation of information like time, wx and news. Usually seen on a non-broadcast channel, MSI may be coupled with a 35 mm slide projector. The slides on the projector can be pictures of local buildings, advertising, and public service messages. The slides flash on the screen for usually 15 seconds and then the MSI unit switches back to the wx, time, news, etc.

Your club can have a Public Service Announcement on the MSI cable channel announcing when the

Continued on page 14



Irwin Dresner W2TRP, with the solid state ATV transmitter which he developed.

Ed Pillar W2KPG, receiving test pattern from W2TRP on LIMARC ATV Technical Net.

SPURRING ATV

Despite the advice of some engineers that it could not be done because of an internal decoupling network, electronics engineer Irwin Dresner W2TRP, of Syosset, L.I. (NY), succeeded in video modulating a Motorola 440 MHz MHW-710 power module with a full 4.5 MHz bandwidth TV signal. His fifteen Watt output signal, coming from a palm-sized solid state TV transmitter, was received by K2RIW, W2KPQ and WA2APJ on September 2nd during the weekly meeting of the LIMARC ATV Technical Net. W2TRP will make full disclosure of his techniques to industry and amateur radio in the hopes of spurring ATV activity.

The ATV Net operates on the LIMARC 146.85 MHz (output) repeater and transmits video on a simplex basis on 439.25 MHz. Signals are receivable throughout the metropolitan New York area each Monday evening from 10 to 11 pm.

I'm enclosing some photos of some LIMARC ATV Technical Net members which you might find interesting.

Ed Pillar W2KPQ
Syosset NY

WA2APJ, Wantagh.

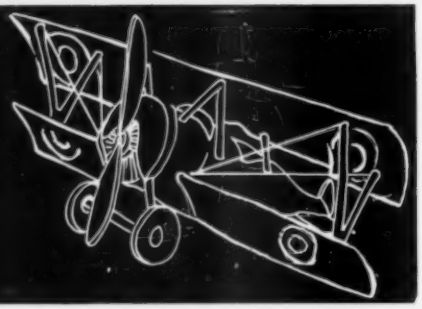
WB2AQM, New Hyde Park.

WA2YQT, East Meadow.

WA2OHM, Massapequa Park.

Autobiography of an Ancient Aviator

W. Sanger Green
1379 E. 15 Street
Brooklyn NY 11230



Back In The Air Service

After the two crashes I told you about last month, I finally got the message about flying the types of civil airplanes that were available at that time. The luck that was with me in the Lindenhurst, Long Island crash, where the ground that came up and hit us happened to be in a field where a fire department was drilling, couldn't be expected to continue. If I wanted to keep on flying, the answer was better equipment. In those days it was either flying mail or getting extended active duty in the Air Service. I opted for the Air Service with the idea that, if I found it was the kind of life Cleo and I wanted, I would take the examination for a regular commission. So I applied for six months active duty. In May 1925 I received orders to report at Langley Field, Virginia for six months active duty from 1 July.

For $50 I bought a model T Ford sedan that I had taken in trade on a new Hupmobile. It was in good mechanical condition so I just piled our luggage in and drove to Langley. When I reported in I was assigned a house that I later found was supposed to be a major's quarters – and I was only a first lieutenant. Too good to be true. A few days later Cleo and Wayne arrived by train.

The ground that came up and hit us happened to be in a field where a fire department was drilling . . .

I was assigned to the 11th Bombardment Squadron. They had one hangar and seven active Martin bombers, plus one in the back of the hangar that was being cannibalized to help keep the rest in the air, and another that was so near the junk pile that, when it was in the air, its tail wagged like that of a dog. These NBS-1s were stick and wire jobs that were built during WW1. They were biplanes equipped with two Liberty engines.

My first flight in one of these bombers was on the 4th of July when, as co-pilot to Capt. Early Duncan, the Squadron commander, we lead a seven ship, three hour, formation flight to Richmond and returned. In a few days I was checked out in the bombers. The NACA (National Advisory Committee for Aeronautics) had a hangar on the field for their experimental planes. Tom Carrol, a very good friend of mine, was their chief test pilot and through his good graces I was able to borrow various types of planes, most of them single seaters, such as Spads, SE5s, Fokker V11s and Vought VE7s, to have fun in. I reciprocated by checking Tom out in Martins.

During my six months tour at Langley I made some 52 cross country flights in DHs and Martins. Some were eventful (mostly due to the very sketchy weather information available), others just pushing the ships along: Bombers cruising at about 70 mph and DHs at about 85 if you weren't bucking a wind. The ground doesn't go by very fast unless you are right down on the tree tops. Some of the more important trips I made were to Bolling Field at Anacostia, D.C., when it was my turn to bring back the 5 gallon can of grain alcohol that was needed each week to keep the "Anonymous Alcoholics" on the "prohibition dry" post properly lubricated. It made about ten gallons of gin, but then there were a lot of thirsty subscribers on the post. If Wayne can remember (he was three years old at the time) he can attest to the gin's potency, as he somehow got hold of a glass with a little in it and choked it down. He was reeling before Cleo realized what had happened.

Around the first of August, Capt. Duncan was transferred to the Command and General Staff School at Fort Leavenworth. I was quite flattered when Major (Tubby) Westover asked me if I would take over command of the 11th Squadron until Lt. Ken Walker arrived in December to be its regular C.O. Westover was Commandant of the Field so I said "yes" even though I knew it meant a great deal of responsibility as well as the loss of what otherwise would be leisure time. So, after an audit of the squadron fund, I took over Capt. Duncan's cigarette pock-marked desk.

The personnel of the 11th consisted of four reserve lieutenants, on active duty like myself, and 124 enlisted men. I inherited an excellent team of noncommissioned officers: a first sergeant who, with the squadron clerk, ably handled the mass of squadron paperwork, daily work assignments, discipline, etc; and a supply sergeant who not only knew his way around Langley but had excellent connections at several other Air Service posts, as well as nearby Fortress Monroe and Camp Eustace. He could get almost anything needed in record time. No questions asked. The mess sergeant seemed to be "grouse" (grumble) proof, which is saying a lot. He had two cooks and two or three KPs (kitchen police) to help, and had to operate on a very tight budget. Our hangar crew of mechanics and specialists and their maintenance shops were bossed by a master sergeant who had been in the service for about 18 years and was "bucking" for a 20 year retirement. Very few things escaped his notice, and when he had inspected a ship and signed it out to the line you could be sure that it was airworthy. These NCOs can teach a young lieutenant much more about running a squadron than any officer's training school. However, a squadron C.O. is needed to oversee and coordinate the work of the several jealously guarded squadron domains.

NCOs can teach a young lieutenant much more about running a squadron than any officer's school . . .

The administrative procedures I set up seemed to work pretty well. The four lieutenants and I took turns at standing the reveille roll call every morning. Two mornings a week I had a short staff meeting attended by the officers and the first, supply, mess and hangar master sergeants, to discuss and settle any squadron problems and also to finalize the next day's operations schedules. The other four mornings a week I was in my office right after barracks inspection to sign papers and to discuss the problems of any of the men. One of the officers or myself had to be available on the post at all times day and night.

About the end of September a major arrived at Langley with his family, so we were moved to a house in the lighter than air section of the field. About a mile from my hangar.

I'll get back into the air again next month with a forced landing or so. Also a tragedy.

AMSAT

Joe Kasser G3ZCZ

At the AMSAT general meeting, the four directors whose terms of office had expired were reelected. The AMSAT board now comprises seven persons: Perry Klein K3JTE, Chuck Dorian W3JPT, Jan King W3GEY, and Bill Tynan W3KMV, who were just reelected to two year terms of office, and Tom Clark WA3LND, Bill Dunkerly, Jr. WA2INB and Larry Kayser VE3QB, who are in the middle of their terms of office. Bob Carpenter W3OTC was later appointed Secretary, Gary Tater W3HUC, Assistant Secretary, and Roy Rosner WB4UOX, Treasurer. The meeting was attended by about seventy persons. Reports were given on the progress of the next radio amateur spacecraft – the Phase III high orbit project – and on the AMSAT-OSCAR 6 and 7 command and control activities, including the changeover to microprocessor control at the ground command stations.

Certificates for the new "OSCAR" Award are available and were first shown at the meeting. Full details of the requirements for the award and of the meeting are published in the December 1975 issue of the *AMSAT Newsletter*.

AMSAT-OSCAR 6 celebrated its third birthday on October 15th and AMSAT-OSCAR 7 its first birthday on November 15th. QSL cards are still available from AMSAT for reception reports of the special relay transmissions from the satellites commemorating these anniversaries. The Jet Propulsion Laboratories (Radio Club) at Pasadena, California held an OSCAR month from October 15th to November 15th, with special exhibits depicting the two spacecraft.

A distance record for amateur satellite relay communications has been claimed by G3IOR and W6CG, for a QSO made over a ground distance of nearly 6000 miles. As this path is well out of direct line of sight range, the contact was made using meteor scatter techniques on successive evening orbits. The QSO took two weeks to complete.

The FCC has authorized radio amateurs in the USA equipped for RTTY to transmit ASCII coded signals through the AMSAT-OSCAR spacecraft for experimental purposes. AMSAT is interested in receiving proposals for and carrying out experiments in transmitting computer data via satellite.

New orbit books for 1976 listing all AMSAT-OSCAR 6 and 7 orbits are available from Skip Reyman W6PAJ, PO Box 374, San Dimas, CA 91773 for $3.00 (or 20 IRCs) postpaid.

W2GN has completed tests operating mobile in motion using SSB, via AMSAT-OSCAR 7 Mode B – with fantastic results. His signals were fully audible over most of the East Coast of the USA during the 15 minutes or so that the spacecraft was within his visibility range. These experiments have demonstrated the superior downlink capability of Mode B. If you would like to listen to really good downlink signals for a change, try listening to AMSAT-OSCAR 7 Mode B.

Support The AMSAT Team That Brought Us OSCAR 6 and 7!

Since November 1974, amateur radio has had not one, but *two* long-life OSCAR satellites available for use by the international Amateur Radio community:

- AMSAT-OSCAR 6. Launched October 15, 1972 by NASA piggyback (with NOAA-2, which has long since expired), OSCAR 6 continues to function, having tripled its original one-year lifetime goal.
- AMSAT-OSCAR 7. Launched November 15, 1974 by NASA piggyback with NOAA-4, OSCAR 7 exceeds the capability of the first six OSCARS *combined*.

AMSAT is now developing Phase III spacecraft, intended for much higher orbits. AMSAT Phase III promises to be a considerable step forward beyond OSCAR satellites launched to date, making possible reliable communications over transcontinental distances for hours at a time.

G3ZCZ displays the new OSCAR award certificate at the AMSAT General Meeting. Photo by W4ART.

AMSAT membership application

Attached is $_____ for _____ years' dues (at $10 per year), and $_____ donation in support of the Amateur Satellite Program. (Approximately half the dues are for subscription to the quarterly *AMSAT Newsletter*, and Life Membership is available for contributors of over $100.)

Contributions above the dues are tax-deductible under Section 170 of the Internal Revenue Code. Thank you for your support!

Name _____ Call _____

Address _____

City _____

State _____ Zip _____

73 *Mail application to:* **AMSAT**, P.O. Box 27, Washington DC 20044

ou goons don't ever proofr
lousy
bunch of rocks
you ignored my
I insist that you print ev

LETTERS

from page 11

meetings are, upcoming hamfests, or whatever you can dream up. You will be wise to keep the number of words at a minimum because the slide has a tendency to look confused with heavy wordage. It also must be pointed out that 15 seconds may be too short for some trifocal wearers to wade through a girthy text.

If your local CATV system has an MSI program, approach the manager and ask him if he has room on his slide projector. He will be more inclined to accept your request if you make the slide yourself. Just have some arty member make an announcement on a 10 inch or so square card and then take a slide picture of it (in color would be a good idea).

Neil Serafin WB2VRZ/2
Syracuse NY

A LOT OF BULL

I'm going to agree with S. Reed and his opinion about *QST* in the October issue. My subscription to *QST* is almost over. I am 13 years old and planning to get a Technician ticket in the near future. By reading an article in *73*, I know a little more than I did yesterday. Steve's letter was most meaningful and I agree with it in every way.

I am going to subscribe to *73* as soon as possible, for *QST* is a waste of time and money for me.

I read *73* whenever I get a chance to. When I do, I turn right to the letters and read the criticism of CB and the CBers. It's unbelievable to find out how many people like CB and the chickens who are on it, but please don't think they're all bad.

I agree that a large percentage of it is just a lot of bull (like channel 10 with the truckers and other stations that don't care if there is someone modulating with another person). If you wish to talk and ask for a break, you won't get one, and, if you do, just try to talk when there are twelve other people talking, plus the mike keyers, garbage mouths and smokey reporters.

If you have a ham ticket, keep it! If you have a CB license – that's alright – don't ruin it or ruin it more. If you're wondering, my father has a CB license, but for me to understand radio I might as well make the best of it with my realistic Navaho TRC/30A. Keep printing those letters!

T. Carlsen
Manlius NY

PINHEAD–PART I

I've been using your 13 wpm code tape for the past few days. It is *definitely* a buster. On my Lafayette player it runs upwards of 16+ wpm, so I use the word thirteen advisedly. I've been a Tech since 1967 and 5 wpm (less numerals and punctuation) used to be like the Myth of Sisyphus. I used to count the dots! I nearly went up the wall with the "IEEIE" code group. Luckily, I'm not an epileptic, or else I'm sure I would have had a grand mal seizure. Gonna take the General exam in a few weeks and if I don't pass the 13 wpm, I'm getting a CB rig and call myself "pinhead". Wish me luck.

Howard J. Margulies WB2FYY
Brooklyn NY

PINHEAD–PART II

After 45 days of bedlam with *73*'s 13 wpm tape, I finally got up the nerve and took the test. Well, I passed, copying roughly 2½ straight minutes before the panic and temporary palsy set in. I guess the realization that this was actually the dreaded "code test" was too much to bear. Now comes the real test of endurance: waiting for my ticket to arrive.

Howard J. Margulies WB2FYY
Brooklyn NY

PROS AND CONS

This is a report on my progress with the *73* code tape I purchased from you. It was the 13 wpm plus tape.

The tape sure did help me over the hump. I was up to about 10 or 11 wpm and could not seem to get beyond that. Mastering that tape did wonders. I spent a total of six hours and thirty minutes with the tape.

I went down to the FCC office here in K.C., Mo., in July, and passed the General test just fine. I then went back in August and passed the Advanced test. I got my General ticket in September and am now waiting for my Advanced ticket.

I think your magazine is the best and those editorials are something else. That is the first thing I read and the next are the letters, which are very enlightening as to the thinking of your readers. Sometimes the pros and cons make me wonder which is right and wrong.

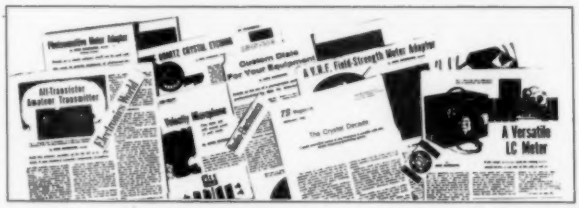
Melvin B. Walker WBØOTW
Raytown MO

Pros are right, cons wrong. – Wayne.

COLLECTOR'S ITEMS

Just a little nostalgia and then I'll get to the point. Back in the late 30s I went to work for RCA Communications out at Rocky Point and got my W2 call – it was W2NSQ. So what you say? Well, wid ur W2NSD, we're both in a pretty close bracket and I have always been able to identify with you for that and a few other reasons. Almost 20 years ago you began publishing your *RTTY Bulletin* – gee, come to think of it, that was *24* years ago! Well, anyway, your Radio Teletype *Bulletin* grew and got a lot of us really turned on, AND provided needed information and techniques. Then came the RTTY column started in 1955 (I believe) in *CQ* when you were running that one. And *then* you had the perseverance, drive, etc., to bring out the *RTTY Handbook*. I have a FIRST EDITION (that was in 1957, if my memory serves me). Anyway, this was just what it took to provide a source of information, a place to go, to get the dope on this RTTY thing. I've been into it ever since!

Well, now what I see coming up is this computer deal! Wayne, this is great! You are coming out with this *BYTE* bit – what a wonderful thing! Comes now a place to find info and knowhow and a chance to really get into this digital scene. So much of it is kicking around but how can a guy get started? Now comes *BYTE* and here is



NO STRINGS

My writing efforts have always been slanted to aid those with limited hobby budgets, by describing more economical methods. Continuing in that vein, in the face of ever-escalating prices, I wish to share an idea which gives more dollars for buying amateur goodies.

For a few years I have enjoyed a free bank checking account which pays 5 percent interest. Personalized checks, air mail stamped envelopes and FDIC insurance are a part of the package. No strings.

Other banks in Massachusetts and New Hampshire offer similar service, but my satisfying experience has been with Home Savings Bank, 69 Tremont Street, Boston MA 02108.

Gene Brizendine W4ATE
Huntsville AL

the answer. Wayne, I'm all for you on this. This is the first step – with *BYTE* going you'll get enough together pretty quick to be able to come out with a computer/digital techniques handbook, and, if I know you, it won't be long coming. So – here is my check for ten bucks to get in on the charter subscription to *BYTE* and I sure HOPE you have a #1 September issue to send along to me – these will be collector's items!

C. P. Cook W5YOU
Houston TX

SETBACK

Amateur radio operators in Tulsa, Oklahoma received a setback on September 18, 1975. The "Tulsa Metropolitan Area Planning Commission" Adjustment Board ruled that amateur operators *do* have the right to have a radio tower and antenna at their residence. However, they ruled, although antennae height was unlimited as far as they were concerned, the tower *is* a structure and as a structure was limited to a 26 ft. maximum height. This ruling is being appealed, of course. The Board indicated that the city ordinance was unclear and needed to be clarified or rewritten. This ruling was made in the case of a group of local residents vs. Jim Picket K5LAD. The Tulsa Repeater Organization, in cooperation with the Tulsa Area Radio Club and the Broken Arrow Radio Club, are drawing up an ordinance proposal to present to the TMAPC to use as a guide for adopting a new ordinance.

Anyone wishing to contribute specific wording or ideas for the ordinance or the K5LAD legal defense fund may do so by sending to Box 1422, Tulsa OK 74101.

Jerry Broderick WB5NXB
Public Relations
Tulsa Repeater Organization
Box 1422
Tulsa, Oklahoma 74101

ALMOST READY

I just wanted to drop a note to you guys letting you know that I am really impressed with one of your advertisers, S. D. Sales Co. Despite today's runaway inflation, an introduction to tomorrow's world of digital electronics is available today with S. D. Sales' Digital Clock Kit on yesterday's experimenter's budget. This is really a relief to get into a new area of electronics and build a device for just a little more than a sawbuck.

By the way, I would like to thank Paul S. Vydareny WB2VUK, Jim Volstad DA1JV and Ken Mahoney K6OPG for the letters of encouragement and assistance in response to my letter published in your May issue of *73*. It will not be long now before I am ready to take my ham exam.

SP5 Kenneth E. Wigger
HHB 1st Bn 1st ADA
APO NY 09077

INTEREST-AROUSING

Enclosed are the orders for certain items and for reader service. I am a teacher of physics, chemistry, and physical science. I hope to start an amateur radio club in the high school soon and possibly affiliate with one of the MARS systems. There is some possibility of starting an electronics class in the future, as there is none now here in the Nuernberg (Germany) American High School for U.S. military dependents.

The high school has a computer and terminal for one class in computer math and one in business computer work. I am subscribing to *BYTE* to learn more about computers, particularly at the hobby level, which should be interest-arousing in high school students.

In the past I have sponsored Electronics/Amateur Radio/MARS (Air Force) in Okinawa and in two different bases in Japan with good response. I hope to create interest here. Any other publications or suggestions along both the radio and the computer lines as applied to high school level students will be appreciated.

I have applied for a German callsign through the U.S. Army, as we are requested to do, via the German Post Office (who issues the calls), but it has not arrived as yet.

J. Worth Gurley W7GH
Nuernberg American High School
APO NY 09696

HAM HAWKS

The article in *73* (October, 1975), by John Murray W1BNN, was certainly nostalgic of early flying and the old Five Meter band. One important and interesting fact omitted by the author, however, was that the famous Frank Hawks was a ham! Indeed. And a good CW man he was. I recall working him several times on 40 meters in 1935. His call was W1IJI.

Ben F. Holloman W5CP
Dallas TX

FIRST RATE

Thank you for putting out a first rate magazine.

Kenneth D. Grimm K4JGI
Sweet Briar VA

LO AND BEHOLD

The FCC exam had me scared. I bought one of those question and answer books, failed the exam, lost 9 bucks, made my wife mad and lots of other bad things.

Lo and behold, *73* says, "purchase one of our books and breeze through the tough FCC exams." Well, I did!

Yesterday (9/3/75) ! passed the Advanced amateur exam. Whether or not I breezed through, I don't know, but you have the best book out, and take it from one who knows.

If you really want a simple explanation to a complex question, purchase a study guide from *73* – and then face the examiner with confidence.

Ancel W. Norris WB4AUB
Birmingham AL

WHERE ARE THEY?

On page 8 of your magazine for October 1975, there's a well written article by a 16 year old. These are my views also. Formerly a general contractor, my knowledge of electronics can be put in a thimble. Why not take heed of this youngster's letter and start devoting articles to us non-egg-heads in electronics? We just want to be ham operators.

I'm a subscriber to both *73* and *QST*, but find little for persons like myself to really read and enjoy.

Just where are all these hams who want to help amateur radio to continue, and help persons such as myself and others to become hams???

Your tapes are helpful.

Basil W. Polenchak, Sr.
Box 81 SV Sta.
Andover MA 01810

ONE IN THE BAG

I have decided to gamble $16 on the presupposition that your magazine will continue to hold my interest for an additional three years beyond my current expiration date. As best my records show, we are talking about extending my subscription to the March, 1981 issue. I'm assuming that you will accept this inflation-fighting effort, understanding that a subscriber in the bag is worth three in the hands of the competition. Therefore, please find enclosed my check for sixteen dollars.

The basic TTL primer article by WB5IRY (Aug. 75) was excellent and much needed to get me started in IC understanding and experimentation.

Keep up the good work.

Joseph R. Nelis, Jr. K3JZD
Trafford PA

ON THE GROUND FLOOR

I enjoy *73* very much. I have been getting it on newsstands, but when I read subscriptions were going up soon I decided to take advantage of the lower subscription rate while I still had the opportunity. So, herewith is my check for $8.00, for twelve issues of *73*. Thank you.

I would like to get in on the ground floor with a charter subscription to *BYTE* but I will have to wait until later in the month. But you will be

Continued on page 20

CONTESTS

CONTESTS & AWARDS from Jock ZL2GX

ASSISTANT CONTEST MANAGER – PETER KENNY ZL2QK

Jock White ZL2GX, one of ZL's best known hams, will be leaving New Zealand by air 12 December 1975 with his wife for a long awaited holiday in the United States. Jock is well known on the bands and through *Break-In*, the NZART Official Journal published monthly. For 27 years he has been Contest and Awards Manager, issuing certificates and awards and writing the column, "The Contest Manager Speaks" (in more recent years, "Contests & Awards from Jock ZL2GX, with Assistant Contest Manager Peter Kenny ZL2QK"). This involves lots of work – sometimes running into five pages of copy faithfully turned out in a busy life (he is the Headmaster of a large school in Gisborne). Jock has fostered ham radio with the same tremendous energy he throws into all his work, and his and Beattie's hospitality to visiting hams has been fabulous.

Visiting ham friends in the US will be an enjoyable experience for them both. If you meet him, he'll hit you like a whirlwind, strike you with his humanity, and leave you the better for knowing him. He's a big man in every way.

NATIONAL CAPITAL DX ASSOC. USA BICENTENNIAL AWARD

The award will be issued to any licensed radio amateur in the world for contacting ten different members of the NCDXA using the special bicentennial callsigns during the 1976 Bicentennial year. Any band or any mode from 1.8 to 29.7 MHz may be used but there will be no endorsements for band or mode or for more than 10 QSOs. The fee for the award is 50¢ for all US stations, but free for all DX. No QSLs are required; send log information only to: NCDXA Awards Manager, Raymond E. Spence W4QAW, 10013 Coach Road, Vienna VA 22180 USA.

NCDXA MEMBERS:

AC3AFM, AC3AFQ, AC3AZD, AC3BQV, AC3BWZ, AD3CHP, AC3COR, AC3CRE, AC3DBT, AC3EZT, AA3HRV, AC3KA, AA3KSQ, AA3MBQ, AA3NHG, AA3NGS, AC3NL, AC3QW, AC3SW, AD3EH, AC3ZNH, AD3ZAW, AC3ZSR, AD4CFB, AD4CTY, AD4DXO, AD4EBY, AD4EKJ, AD4GKD, AC4IDG, AC4KFC, AD4KQB, AD4OMR, AC4QAW, AC4UMF, AC4WSF, AD4WVT, AC4WWG, AC4DPS, AA4HPF, AB2EXK, AC2GHK, AC9SZR, AC3RX.

DELAWARE QSO PARTY

Starts: 0001 GMT Saturday, December 6
Ends: 2400 GMT Sunday, December 7

This year's Delaware QSO Party is sponsored by the Delaware Amateur Radio Club W3SL, and is open to all amateurs. Stations may be worked once per band, per mode, for point credit.

EXCHANGE:

Delaware stations give QSO number, RS(T), and county. All others give report and ARRL section, province, or country.

FREQUENCIES:

CW: 3560, 7060, 14060, 21060, 28160
Phone: 3975, 7275, 14325, 21425, 28650
VHF: 50.110, 146.52
Novices: 3710, 7120, 21120, 28160 Phone on even hours, CW on odd hours.

SCORING:

Delaware stations score 1 point per QSO times number of sections, provinces, or countries. Outside Delaware, score 5 points per Delaware QSO times 1 for one county worked, 3 for two counties worked, or 5 for all three counties worked (New Castle, Kent, Sussex).

AWARDS:

Awards will be given out, as well as certificates for working all three Delaware counties.

LOGS:

Mailing deadline is January 15, 1976; include an SASE for results or W-DEL Award. Logs should be sent to John Low K3YHR, 11 Scottfield Dr., Newark DE 19713.

MILWAUKEE AREA CHAPTER OF THE 10-X NET QSO PARTY

Starts: 0001 GMT Saturday, December 6
Ends: 2400 GMT Sunday, December 14

Stations may be worked on all bands, once on each band. All contacts must be made using voice transmission.

EXCHANGE:

IDs, QSO number, Milwaukee Chapter number, 10-X number, and state.

SCORING:

Score one point for each initial contact, 1 extra point if on 10 meters, 1 extra point if station is a 10-X member, or 1 extra point if station is in Wisconsin. Score 2 points if person contacting is a Milwaukee Chapter member. Thus, one QSO could score 6 points total.

AWARDS:

Plaques to the first and second place winners. Certificates for the next two highest scorers in each state (3rd and 4th).

LOGS:

Logs must list exchange information plus date, time and band. All logs must be received by WA9TSG no later than January 15, 1976. All logs will remain the property of the Milwaukee Area Chap. of the 10-X net. Send logs to: Joseph F. Williams WA9TSG, 114 East Brown Street, Milwaukee WI 53212.

TELEPHONE PIONEER QSO PARTY

Starts: 1900 GMT Saturday, December 6
Ends: 0500 GMT Sunday, December 7

The Stanley S. Holmes Chapter Ham Pioneers invite all Telephone Pioneer ham radio operators to participate in contacting as many individual members in as many different chapters as possible. All bands may be used and the same station may be worked on more than one band. General call is "CQ TELEPHONE PIONEERS" or "CQ TP" on CW.

EXCHANGE:

RS(T), number, chapter name and number.

SCORING:

One point for each completed exchange and one point for each different chapter contacted.

SUGGESTED FREQUENCIES (± 20 kHz):

Phone: 3965, 7206, 14295, 21365,

28675, 50.1 to 50.25 & 144.275 to 145.5
CW: 3565, 7065, 14065, 21065
REPORTING:
Send log extract showing date, time, station worked, chapter name and number, contact number – postmarked not later than January 10, 1976 – and send to: Gene Przebieglec, Stanley S. Holmes Chapter No. 55, Telephone Pioneers of America, 100 Central Avenue, Kearny NJ 07032.

TOPS CW CONTEST
Starts: 1800 GMT Saturday, December 6
Ends: 1800 GMT Sunday, December 7

All contacts must be made between 3.5 and 3.6 MHz. On CW, leave the low end of the band for DX. General call is CQ QMF.
SCORING:
Contacts with own country count one point – each call area in W/K, UA, etc.; VE/VO and VK counts as a separate country. Contacts with stations in same continent count two points. Contacts with stations in other continents count five points. Total score is total points times number of prefixes worked (prefixes same as for WPX).
LOGS:
State if single or multi-operator and mail logs not later than January 31, 1976 to: Peter Lumb G3IRM, Tops CW Club Contest Manager, 14 Linton Gardens, Bury Saint Edmunds, Suffolk IP33 2DZ, England.

ARRL 10 METER CONTEST
Starts: 1200 GMT Saturday, December 13
Ends: 2359 GMT Sunday, December 14

The contest is open to all amateurs worldwide. All QSOs must take place on 10 meters and OSCAR QSOs are valid. Each station can be worked on phone-to-phone and CW-to-CW, and anyone can work anyone. All CW contacts must be made between 28.0 and 28.5 MHz, unless working through OSCAR. When operating on 10 meters, please avoid the OSCAR downlink frequencies.
CLASSES:
Entries will be classified as either single or multiple operator stations. Multiple transmitter stations are not allowed.
EXCHANGE:
All W/VE stations will send RS(T) and state or province. Others will send RS(T) and consecutive serial number starting with 001. Stations that are not land based will send RS(T) and ITU Region (1,2 or 3). The District of Columbia is counted as part of Maryland.
SCORING:
Each completed QSO counts 2 points, or 4 points if with a W or K novice. The multiplier is the sum of the total number of states, Canadian call areas (max. 9), ARRL Countries (not US or Canada), and ITU regions from non-land based stations. Final score is the sum of the QSO points times the total multiplier.
AWARDS:
A certificate will be awarded to the highest scoring single operator station in each section, Canadian call area, and foreign country. Region awards for non-land based stations, and awards for multi-operator and Novice stations will be issued if warranted.
FORMS:
It is suggested that contest forms be obtained before the contest from ARRL, 225 Main St., Newington CT 06111; include an SASE. Check sheets are not required but a penalty of 3 additional contacts will be made for each duplicate contact.
These rules were taken from last year's contest; for complete rules see the November issue of QST.

HA5 – WW CONTEST
Starts: 0000 GMT Sunday, December 28
Ends: 2400 GMT Sunday, December 28

The full 24 hours may be used on all bands/modes. Classes (sections) include: single op, multi-op, and SWL. General call is WW TEST DE . . .
EXCHANGE:
RS(T) and ITU zone number.
SCORING:
Contacts within own continent count 1 point, between continents 3, with HA/HG5 stations 4, and 5 points with the special HA5 prefix. Multiplier is the number of different ITU zones.
AWARDS:
Certificates to the top scoring stations in each category, in each country.
LOGS:
Send usual log data, summary sheet, and signed declaration to: BRAL Contest Committee, PO Box 214, Budapest 134, HUNGARY.

NOSTALGIA RADIO EXCHANGE
Starts: 1900Z Saturday, January 3
Ends: 0500Z Sunday, January 4
Starts: 1900Z Sunday, January 4
Ends: 0500Z Monday, January 5

Nostalgia Radio Exchange is sponsored by the Southeast Amateur Radio Club, Cleveland, Ohio, and is open to all. The object is to have civilized fun in working as many interesting persons and old rigs with your interesting old rig (a Nostalgia Rig is any gear built since 1945 but at least ten years old – an advantage, but not required in the Exchange).
EXCHANGE:
Your name, RST, state/foreign country, transmitter type (home brew: Use P.A. tube, i.e., "807"). The same station may be worked on each mode on each band. No AM phone below 28 MHz. CW call "CQ NX," phone call "CQ Exchange."
FREQUENCIES:
1810 and CW up 70 kHz from low band edges; phone 3910, 7280, 14280, 21380, 28580; Novice 3720, 7120, 21120, 28120.
SCORING:
To score, add the numbers of different transmitters, states and countries for each band. Multiply by total number of QSOs. Multiply that total by Nostalgia Multiplier: total years old of your transmitter and receiver (if transceiver, multiply years old by 2). Different transmitter and receiver combinations may be used by one station: Figure scores separately for each and combine for total score.
AWARDS:
Achievement Certificates for persons scoring 150,000 or more, plus Special Citations for unusual circumstances as determined by the committee (like working Antarctica with an AT-1). Send logs, comments, anecdotes, and legal sized SASE to Southeast Amateur Radio Club, c/o W8KAJ, 2386 Queenston Road, Cleveland Heights OH 44118.

Don't forget to send early for your contest logs and summary sheets for the ARRL VHF Sweepstakes (Jan 3 - 4) and the ARRL DX Competition (Feb 7-8 and 21-22). Include a large SASE with sufficient postage. Send requests to: ARRL, 225 Main Street, Newington CT 06111.

CALENDAR

Dec 5 - 7	ARRL 160 Meter Contest*
Dec 6 - 7	Delaware QSO Party
Dec 6 - 7	Telephone Pioneer QSO Party
Dec 6 - 7	TOPS CW Contest
Dec 6 - 14	Milwaukee Area Chap. 10-X Net QSO Party
Dec 7	TU2 Competition
Dec 13 - 14	ARRL 10 Meter Contest
Dec 28	HA5-WW Contest
Dec 31	Straight Key Night
Jan 3 - 4	ARRL VHF Sweepstakes
Jan 10 - 11	ARRL CD Party – CW
Jan 17 - 18	ARRL CD Party – Phone
Jan 24 - 25	Simulated Emergency Test
Feb 7 - 8	ARRL DX Competition – Phone
Feb 21 - 22	ARRL DX Competition – CW
Apr 3 - 4	Florida QSO Party
May 1 - 2	Helvetia 22 Contest (H22)

* = described in last issue

Looking West

Bill Pasternak WA6ITF
14725 Titus St. #4
Panorama City CA 91402

In case you had not noticed, 1975 has fast drawn to an end, and to say that it has been a most interesting year for amateur radio would be an understatement. Nationally, the controversy brought about by Docket 20282 and the profound long reaching effect that the final report and order would have on the future of the amateur service has stirred the thinking of just about all of us. It has made many of us realize that the key to our survival and growth is recognition and total acceptance by the general public. It is still my sincere feeling that you cannot legislate people into the amateur radio community; through the proper education, though, we can instill the necessary desire and interest for them to take their own initiative to join our ranks – because becoming a "ham" holds the kind of challenge they find necessary in their lives. In '75 we saw the dawning of this new era first with the Hawaii Ham Forum, a radio program produced by members of the Hawaiian Amateur Community and directed specifically toward the non-amateur listener. As the realization that it would inevitably be the general public that would decide the destiny of amateur radio took hold, and that the best way to reach the public was through the broadcast media, the ARRL leadership here in Southern California was quick to act by appointing Lenore Kingston Jensen W6NAZ (a person whose credentials for the job would take a column in itself) to the post of liaison with the broadcast media in Southern California. Lenore is the type of person one feels honored to know is a member of our amateur radio community.

We have come a long way in '75, and challenges still await us in the coming year. Such a challenge is the future of a statewide FM coordinating body known as the California Amateur Relay Council. If you are a regular reader of LW, then you are aware of the fact that CARC is in the process of total metamorphosis. Racked with dissension from within the organization itself, charges that the organization was not responsive to the needs of northern repeater interests, and the fact that a split was developing between repeater and non-repeater interests, the organization took on the job of revamping its structure in order to try in some way to placate all concerned. A blue-ribbon committee was formed, given time to study all related matters, and, as reported in an earlier column, voted in October as to which direction to take. We will have a report on their decision next month.

In the interim, however, another organization is in the process of getting itself together in Northern California. As the Southern California Repeater Association was formed a few years ago when local leaders here came to the realization that the existing statewide body was not at that time serving their needs and interests, so it appears that similar interests in the north are following in the same direction with the announcement that the Northern Amateur Relay Council (or NARC for short) had been the outcome of a meeting held September 20th in Sacramento. Hosted by the Mt. Vaca Radio Club, this meeting was well attended by some 200 delegates of both repeater and remote base interest. It was agreed by the vast majority that some form of regional "home rule" organization could best be responsive to the needs of area FMers, and a group of eight area amateurs plus one alternate was chosen to represent the organization and help get it started.

Well, the year end "box scores" are in regarding repeater operation in the Southland, and here, directly from the latest SCRA Newsletter, is where we stand. Two meters is bulging at the seams with 61 systems currently sanctioned to the repeater sub-band, plus (unfortunately) 5 systems whose owners do not feel that coordination is necessary. Of the 61 coordinated systems, only 15 are listed as private, with the rest being considered "open." Six of these systems are listed as having autopatch facilities, but it is best to check with a given system (as to whether this facility is open to all or limited to specific individuals) before going "gung ho" on such a repeater. The channel pair of 146.10-.70 is reserved for RTTY repeater operations.

Now, here is the best part: Nine of the above are inverted or "California Plan" split-split systems, and no one to date has come running to the SCRA Technical committee yelling foul! It looks as though this method of using the 15 kHz tertiary channels is meeting with good success, much to the credit of Burt K6OQK and Bob WB6JPI, who thought it up, and to the SCRA, for accepting this radical departure from tradition and having the wisdom to give something new a chance to be experimented with. Of late, reports have been reaching me that other areas of the country have been considering going this route rather than following the Texas Plan (that does not invert the tertiaries). As one who had the sometimes dubious honor of being among the first to try a split-split repeater according to the Texas Plan (doing so at a time before the Texas Plan was known as the Texas Plan), and now witnessing firsthand the results of the Southern California Inverted Plan, I only wish that I had been the one to dream this one up myself. If you reside in a megalopolis such as ours, with all your standard 30 kHz channels allocated and in use, might I suggest that you give serious consideration to what has been accomplished here? The inverting of the split-splits is a reality and, moreover, it is a success. Simply said, it works. A letter to the SCRA at PO Box 2606, Culver City CA 90230 (and marked to the attention of Tech Committee Vice Chairman Bob Thornberg WB6JPI) will probably bring you as much information on this topic as is available to date.

Now, can you believe 30 systems already sanctioned to 220 MHz with the number still increasing? Now remember that a sanction does not mean a machine is in daily operation, but it does stipulate that the amateur receiving said sanction has but 90 days to get his system operational (and within SCRA guidelines). All these systems must be on the air by January, or the channel assignments will be up for grabs. My personal opinion is that most if not all will make the deadline – thereby making L.A. and vicinity a veritable beehive of 220 activity.

My Clegg FM-21 is crystalled for five of the listed systems, plus 223.5 simplex. Of these five, two are in regular operation, with WR6AER accounting for the bulk of the activity. While two out of five might not seem like a lot, in terms of percentages it comes to 40% of my crystals being useful. A directional antenna on 220 would do wonders for the other 60% (they're all for operational systems) as well as my simplex range. As for the latter, there is a darn nice bunch of people operating 223.5 here in the San Fernando Valley, and most of the time when the 220 radio is on, it monitors that frequency. If I am home, a short call on that channel will usually get a response. If I am not home, well, the phone number is 786-6829 and Sharon is adept at taking messages . . . hi.

So there is the total: 91 sanctioned repeaters, one special events sanction and five unsanctioned or renegade repeaters – all within the "jurisdictional boundaries" of the SCRA (and currently nine more applications pending for coordination to two meters). I find it all but mind-boggling how FM has grown in the three years since we arrived here. Grown? No, skyrocketed!

There are still no purely open 450 systems in the area yet, but rumors persist that this situation will soon be changing. Activity on that band is such that a non-area ham might have trouble believing that so much activity could be packed so tightly into one band. I didn't, until I was given a firsthand demonstration about a year ago. The technological level of some of the 450 remotes and repeaters is

probably the most sophisticated in the world – a credit to the inventiveness of the amateur radio community.

Alas, this leaves us with but one veritable wasteland, six meters. While there is a fine open repeater system, WA6UJS, located atop Mt. Wilson, with coverage that rivals anything else in the area other than WR6ABE (2 meters, also atop Mt. Wilson), it is rare that I hear any activity on that system. I understand that there is another system down San Diego way, but I cannot hear it from my location. Going to the low end, aside from a few AM nets and a minute amount of SSB activity, there is little to speak of. Even when the band was "open" during "E" and "F2" skip this summer, there was not much activity to be noted. Oh, the "Big Gun" DXers were there, but that was it. No new blood – that was the six meter scene about five years ago. Even with the availability of multi-channel amateur FM transceivers, six meters seems to be going in the opposite direction from 144, 220 and 450. Days can go by without hearing anything but the few AM nets. A sad commentary on a great band!

I hate to see 6 just go down the tubes. Oh, I hear the same old reason given time after time: TVI. But let me pose a question. Aside from the TVI potential of the repeater transmitter itself, and this can be located in an area isolated from TV viewers, how much TVI can you give from your car? Do you really think someone is going to run out of his home to complain as you sit waiting for the traffic light to change? Sound silly? So is the old TVI excuse for avoiding six! It might have held some merit back in the pre-FM repeater days, but a lot has changed over the past few years.

Now there is rumbling coming from Washington that the television industry wants the band back to create a channel 1 TV station for educational purposes. Do we sit idly by and wait for the day when the FCC says, "Pack up your Gonsets, guys, it's not your band any longer" or do we start now to populate this band in numbers that will avert its eventual loss? Don't think it can't happen; remember the Class E CB thing of a few months ago? A good motto for the next 12 months might be "Save 6 in '76" or something along those lines. It's a darn good band with tremendous growth potential. Let's not lose it.

The mention of television brings us to the question of the media and our relationship with it. We have two things to report this month, one older news and bad, the other new and very good. First to the former. If you have not already heard, the production team of Spelling-Goldberg (the company that brings you the police action drama show *SWAT*) is in the process of readying an episode of that program that puts the amateur radio community into a rather unfavorable light. It seems that the "bad guy" in the particular episode is a "ham" who uses his radios to befuddle the police. It seems that Mr. Spelling is not willing to make very many concessions if any as to dialogue (something that as a producer he has the artistic privilege to handle in any way he sees fit). Therefore, until the episode airs on ABC, no one is exactly sure of what will be contained therein, and though I hate to seem pessimistic, I doubt if a letter writing campaign will do much to keep it off the air. This may be one where we lose the battle, and can only hope for minor consequences as a result. If the content of the show is such as to be deemed slanderous to the amateur radio community, then legal action can only be taken after the program airs. In the interim, we must take a wait-and-see attitude; we have no other option. The only thing that bothers me is that with the multitude of amateurs within all aspects of the media, and a good possibility of there being one or two employed by this production company, why didn't they put out feelers for an episode technical advisor from within the Los Angeles amateur community? Why is it so rare that the media ever consults us when they are going to picture us? These are the questions and barriers that we must work to overcome, and this is what good public relations is all about.

Now that we have expounded on the dark side, let's get to something good. Educating the younger members of our society, the children, is one way to insure our future growth. If we can instill in them a feeling that amateur radio is a challenge of the future, then half of our problem is solved. Reaching these little people through children's programming is one way, since the reason that children watch TV is that they enjoy it. One of the top rated children's programs is the Saturday morning show *Shazam/Isis*, a two part program actually with two separate programs in a one hour slot. (Consult your local TV listings.) I am pleased to be able to report that Art Nadel W6TZY has written a script for *Isis* titled "No Trumpets, No Drums" that is now in production and will be aired in the near future. It will, I am told, depict amateur radio to our younger generation in a proper light – and one that they will be able to understand. Since no air date is available yet, watch your local TV listings for the title. If it's as good as Lenore says, and I never doubt her word, it may be the first step toward a new generation of amateur operators.

And with this, we begin another year. At this point a personal note to you all: Thank you for your ongoing Xmas gift – the letters of support and encouragement that arrive throughout the year. It's these letters that let me know what you want to hear about, and I consider you all an important part of this ongoing monthly endeavor. It is you who make Looking West possible; you are as much a part of it as I am.

To each of you individually, Sharon and I send our warmest wishes for a most joyous of holiday seasons and hope that all the dreams you have for the future come true in '76.

Save Six in Seventy-Six

LETTERS

from page 15

getting my money for that interesting journal, also.

I enjoy every feature of *73*, even your editorials. Some of them I agree with and some not. But mostly for. You have a lot of common sense in your arguments and I like that very much. You can quote me.

Francis K. Cassels W1GVA/1
Calais ME

CAN YOU BLAME US?

In the September issue of *73*, Mr. Glenn Knight commented on my piece in July's "Be My Guest." Mr. Knight puts forth a strong argument that many people are interested in amateur radio but are unable to find a willing ham to show them the right way. As much as I hate to admit it, Mr. Knight is correct. Too many hams don't really care if the ranks are growing smaller. Many hams don't care much about their hobby in general anymore, and that is a shame.

I wrote my article on public relations for those people who are willing to go out and grab the chance to interest people in amateur radio. I wrote the article from my own experience and I was lucky enough to have several hams around that would bend over backwards to help. But I do agree with Mr. Knight that there are far too many hams around that are prejudiced and turned off to those who aren't yet well versed in the ways of hamdom.

Hams in general are prejudiced. They are prejudiced against lower classed hams, higher classed hams, hams that work a different mode, hams that have different interests. Almost all hams are against CB and I guess I'm no exception. We see them getting something for nothing and then using it wrong – while we work for what we have. How can you blame us?

Nonetheless, CBers are our biggest reservoir of prospective amateurs, and we should be showing them the way. Mr. Knight says that CBers talk to anyone and that fact only will turn people the CB way. We, as amateurs, who enjoy our hobby, have to get out and be friendly and quit being so damned snobbish. Such a hard thing to do for some, but it might be the key to keeping our hobby around.

Some hams don't realize why I'm putting on such a push for enrollment. It is the simple fact that the ITU conference, to be held in 1979, will say yes or no to the existence of amateur radio in the US. The FCC is in fact trying to help through Docket 20282, but I do believe they're not quite on course with their suggestions. There must be enough amateurs to show a need for existence. As usual, nobody looks at what we are doing but instead how many of us there are doing it.

To save amateur radio we must increase our numbers. If all we have to do to do that is be friendly and give others our knowledge, let's do it!

Mark D. Poss WB8URH
1365 Brookside Dr.
Fostoria OH 44830

TRIPPING

I am planning to make a trip around the world after I graduate from college in December. I would like to know if there are any amateurs in Japan, Israel, Scandinavia, Western Europe, the British Isles, or French Canada who read *73* and who would like a visitor from the United States. I'm 22 years old, a linguistics major who speaks several languages, and am very interested in making contact with amateurs in the countries mentioned that I plan to visit. All replies will be appreciated, and answered.

Jon Forrest WB6EDM
21414 De La Osa St.
Woodland Hills CA 91364

PROGRAM OFFER

With regard to "Say, OM, Are You A Computer?" (October, 1975, p. 109), the program's writer makes the following offer:

He will send a punched paper tape copy or a listing of the program to anyone who writes him to ask for it, and includes a dollar to cover his costs ($2.00 for both). His address is:

Robert Snider, Jr.
57 Hawxhurst Road
Huntington NY 11743

Frank Kelly W2IAT
Huntington NY

BAMBOO DX

I built the "El Cheapo Superbeam" of WA6NLQ's, which was in the June 1975 issue, and it is working very well – I got my first DX across the ocean on it first day of use.

I had trouble finding 13 foot bamboo poles, but 9 foot bamboo and 2 x 2 lumber worked fine.

Charles McBride VE3GYT
Grimsby Ont

PUSHING HAM

I just wanted to say "thank you." Reason? I've been involved with CB (please read further) for about 11 years. After reading *73 Magazine* for about 7 months now, the philosophy of international communication finally got through my thick head. I own a small CB business and am starting to lose a little business – but gaining in cleaning the air waves. By this I mean I've started on my way to becoming a Novice. Thanks again! I push ham every chance I get now!

George Weed
Vineland NJ

OL' KEN

IDF has done it again w/his HW-7 article! Ol' Ken's writing is purely delicious! Bet you edit it very little.

Encouraging trend now in NW is more code classes and more requests for info on becoming hams!

Anxiously awaiting my copy of new VHF Antenna Handbook . . .

Clair L. Mackie W7IJY
Everett WA

INVALUABLE

After several years of your magazine and many interesting and informative articles, I decided that it was time to write and let you know that your magazine is read and appreciated. The articles on surplus and antennas have been invaluable guides to operating on a rather meager hobby budget. The FM articles have been interesting and encouraging enough to get this confirmed HF brass pounder to consider putting a rig on Two Meter FM.

Thank you very much for your time and keep up the good work with the magazine.

Robin D. Huckaby WB4GKI
Norcross GA

CAUTION

I am writing in regards to Sig Peterson's letter in the October 1975 issue relating to the HP-45 "timer." You should caution your readers that it is a counter and not a timer. The timing has not been calibrated by HP and therefore runs at an uncalibrated speed. My HP-45, for instance, is six seconds slow over a ten minute period.

J. Bradley Flippin K6HPR
San Diego CA

IF ONE GETS IN. . .

How about running more articles on inside antennas for some of us who live in one story complexes with a small attic and no floor? No outside antennas are allowed. In fact, no wires are visible; everything is underground.

Also, how about some articles on TVI filters for 6 meters? This was a busy band, but today it's practically dead. We're blessed with channel 2. Everyone is going 2m FM and 50 MHz is a graveyard. I understand some Dallas outfit has petitioned the FCC to use 50 MHz for a TV station. If one gets in, that's it. We can't afford to lose any frequencies.

Sherman Goldman K8LUY
Southfield MI

CASH SUPPORT

Enclosed is $26. Please renew my subscription to *73 Magazine* for three years and give me a one year charter subscription to *BYTE*.

I'm parting with all this cash to support your editorial policies of telling it like it is and providing the most ads and articles each month.

I also share your enthusiasm for microprocessors and spent part of this morning ordering parts for my system. I'm basing my system on the MCS6502, an 8 bit NMOS chip just made available by MOS Technology, Inc., Norristown PA – for the bargain price of $25. They plan on introducing a combination 64X8 RAM, 1024X8 ROM, 16 bit I/O chip this fall – also for about $25. Their ROM portion is not field programmable, but will be supplied factory coded with either a teletype input monitor or a keyboard input, CRT display output monitor. The monitor programs will allow you to enter programs from your keyboard on TTY, then execute them. To my knowledge, this is the least expensive way of getting a system up and running. The MCS6502 is comparable to the Intel 8080 and the Motorola M6800.

I have some news of interest for 8080 users. In mid-August, Intel introduced the 8080A, a redesigned 8080 with full TTL drive capability on all outputs for $150. At the same time, they announced a number of new LSI support chips, including:

8708 – 1024X8 erasable PROM 450ns;
8224 – clock generator/driver;
8228 – system controller/bus driver;
8214 – interrupt controller;
8255 – programmable peripheral interface (24 bits of I/O);
8251 – teletype interface chip (5 level or 8 level).

For $250, Intel distributors (Cramer) will sell you a 13 chip set including an 8080A and one each of the above chips. I ordered a set when they were first announced for a company project, but it wasn't scheduled for delivery until mid-October. These new chips allowed me to design a complete system, including 2KX8 PROM, 1KX8 RAM, CPU and I/O, on a single 5.5" x 7" printed circuit board.

I'm also designing a 12KX8 RAM board using 4KX1 dynamic RAMs. These currently go for $23 each, but by the end of next year I expect they'll sell for ½ of that. Refresh requirements can be handled automatically with about 10 ICs with minimal interference with the microprocessor.

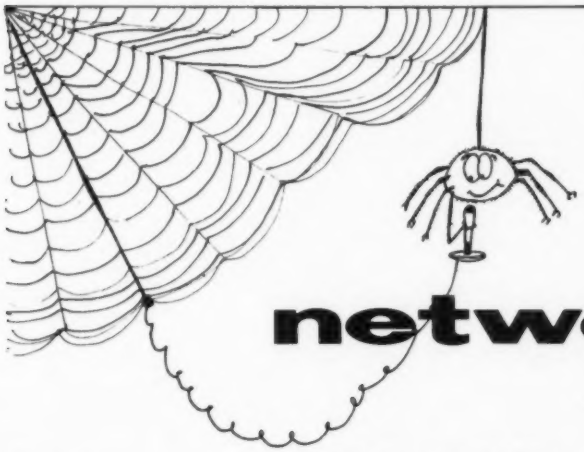
Jack Regula WA3YGJ
Conshohocken PA

SUGGESTION

If there is a ham who has a General ticket (or above) and wants to help others, here is a suggestion.

Many Novices and non-hams enjoy listening to the voice bands. If a General ham would give instruction to the Novices and non-hams, it would be great! A General class ticket is very important to me and other Novices, I'm sure.

Carl Rubin WN2UOQ
Chappaqua NY



networks

E. H. Barnett WBØIIX
Route 1
Ashland, Missouri 65010

NOTE: Times and Days are given in GMT.

NET TYPE

I – Information
R – Rag Chew
S – Service
T – Traffic

My wife and I had a nice vacation last month. While driving through some pretty isolated areas of Wyoming, we both found it comforting to check into the Independent County Hunter's Net (14.333 MHz all day). We were in places where it was 50 to 60 miles to the nearest service station and CB was useless in case of emergency. Viva la difference! Apparently the news travels slowly from Washington – people in the mountain states were driving at whatever speed they wanted to.

My thanks to WA5RON, WBØLSI, K4FRX, WB8TFP, K4HXW, K8YFX and others who dropped me a note telling of their nets. They are included in this edition.

INTERCONTINENTAL

Service Area	Net Type	Name	Time	Days	Freq	Mode
	S	Intercontinental Mission Radio	0100	Mon--Fri	14280	USB
	R	Saltminers	1000	Daily	7285	USB
Western Hemisphere	S	Intercontinental Mission Radio	1800	Mon--Sat	14280	USB
NATIONWIDE						
United States	S	Independent County Hunters	Cont.	Cont.	14333	LSB
United States	S	Interstate R-V Service	0100	Tu--Sat	14308	LSB
United States	R	Corn Cob Net	1100	Daily	7274	LSB
United States	S	Interstate R-V Service	1700	Mon--Fri	14308	LSB
REGIONAL						
East United States	S	R-V Service	0000	Tu--Sat	3895	LSB
East United States	S	R-V Service	1230	Daily	7278	LSB
East United States	S	R-V Service	1300	Sun	3963	LSB
Northern Mid U.S.	T	Piconet	1300	Daily	3925	LSB
West United States	S	R-V Service	1800	Mon--Fri	7263	LSB
Northern Mid U.S.	T	Piconet	1800	Daily	3925	LSB
STATEWIDE						
NC	T	North Carolina SBN	0030	Daily	3938	LSB
FL	T	Florida SBN	1100	Mon--Sat	3940	LSB
FL	R	Knights of the KC	1130	Mon--Fri	3910	LSB
MW	T	Midwest CW Net	1800	Sat	3725	CW
MN	T	MSSN	2300	Mon--Fri	3710	CW
SC	T	South Carolina SBN	2300	Daily	3915	LSB

Clocks...

by
Larry Kahaner WB2NEL
4259 Bedford Ave.
Brooklyn NY 11229

A clock is a device that emits pulses at designated intervals. The pulses, either logic 0 or 1, can be used to synchronize different parts of a circuit so they function or turn on at the same time . . .

All right already: what's a clock? That's what many readers have asked, and this article not only answers the question but shows how to build one and incorporate it into a complete IC experimenting unit. And to satisfy those who have asked for simple projects to show IC logic "even if they don't do much," we have that, too.

First, a clock is a device that emits pulses at designated intervals. The pulses, either logic 0 or 1, can be used to synchronize different parts of a circuit so they function or turn on at the same time. For instance, we may have five flip flops in one circuit and want them to activate together. By connecting them to the same clock we are assured that they operate simultaneously.

If we have a clock that pulses at one second intervals and it drives a seven segment LED so that numbers are counted, we have a clock, in the everyday sense.

555 IC Chip

The heart of the clock is the 555 IC chip shown in Fig. 1. The internal circuitry is complex. The equivalent circuit made of discrete components takes over twenty transistors, half a dozen resistors and a few diodes. It is a linear device.

It has many uses, but the two most common ones are astable operation, where it continues to emit pulses, and monostable, or "one shot," where it acts as a timer and pulses once at a predetermined time.

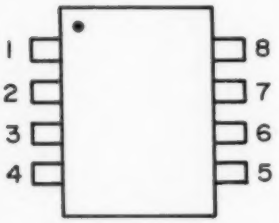


Fig. 1. 555 timer. 1 – ground; 2 – trigger; 3 – output; 4 – reset; 5 – control voltage; 6 – threshold; 7 – discharge; 8 – Vcc.

The circuit for the one shot timer is shown in Fig. 2.

Pin 2 is the trigger and a pulse under 1/3 Vcc will set an internal flip flop. This flip flop releases the short circuit on C_1 imposed via pin 6. This in turn drives the output (pin 3) high. The capacitor now starts to charge (remember $\tau = RC$) and when it reaches 2/3 Vcc the flip flop is reset by a comparator and the output goes low, as the capacitor discharges quickly. 2/3 Vcc is the threshold voltage.

A very good feature is that once triggered, the clock will not retrigger until the elapsed time is up. Then it can be manually reset. However, if we do want to retrigger it during the timing cycle, all we

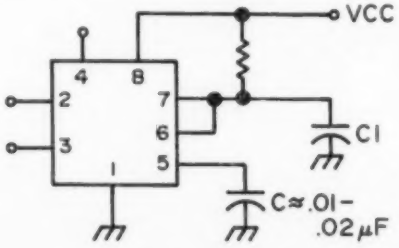


Fig. 2. One shot timer.

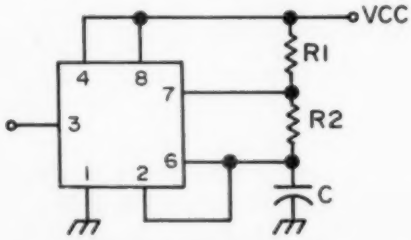


Fig. 3. Astable operation.

Really Simplified!

have to do is pulse both pin 2 and 4 at the same time and the cycle will start again.

To prevent accidental retriggering during a timing cycle, pin 4 should be connected to Vcc to insure that it cannot go low. The equation for timing is approximately $t = RC_1$. R is given in Ohms and C_1 is in farads. With the proper values, timing from many hours to hundredths of a second can be obtained. (For an application see "The Alligator Squelcher," *73*, Sept. 75.)

The astable operation is the mode we have been discussing most of the time. The circuit is shown in Fig. 3.

It is similar to the one shot except that pins 2 and 6 are connected together. That's right; it triggers itself. The capacitor charges to 2/3 Vcc, then discharges. When it discharges to 1/3 Vcc, the clock triggers via pin 2 and another cycle commences. 1/3 Vcc is known as the trigger voltage. The cycle is dependent upon R_1, R_2 and C. The frequency is equal to $1.4/(R_1 + 2R_2)$ C. The graph makes it easy (Fig. 4).

Building the Clock

As you can see from Fig. 3, there is not much to it. After I breadboarded it, I just took the whole thing and mounted it inside the same chassis as the 5 volt power supply. Parts layout is not critical (I always wanted to say that), and since the clock draws so little current, I leave it connected to the supply output all the time.

To obtain variable speeds two choices are available. One is to vary the resistors, the other is to vary the capacitor. Because I had no potentiometers of the correct value, I decided to leave $R_1 + 2R_2$ constant at 10 megohms and use a rotary switch to select a 1, .1, .01 or .001 uF capacitor. This gives speeds of .1, 1, 10 or 100 Hz. For a precision clock, keep adjusting until the proper speed is reached while checking against a known reliable source like an oscilloscope or counter.

If an LED is connected to the output (you may need a dropping resistor of 150 Ohms or so depending upon your LED), and the speed is slow enough, you will see that it stays on longer than it blinks. This is correct. As mentioned before, the output is high during the timing cycle. However, the change is the important thing and that occurs at the proper time according to the RC ratio. The logic state in the "between times" does not really matter.

No excuses for non-IC experimenting will be valid after this article is digested . . .

Continued

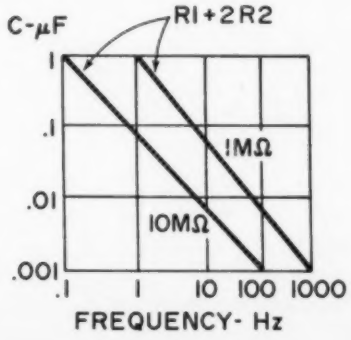
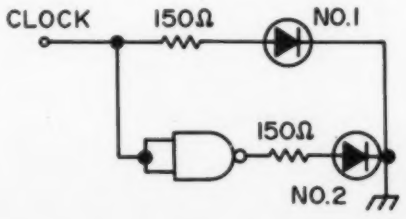


Fig. 4. Values of R_1, R_2 and C versus frequency.

Fig. 5. 7400 IC blinker.



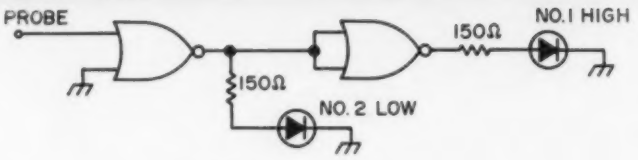


Fig. 6. Logic probe using NOR gates.

The Permanent IC Breadboard

When experimenting with ICs, we can find ourselves in a wire jungle. The innocuous 14 pin chip can strangle us in its spidery tentacles. The permanent breadboard will save us. It is simple to build and convenient to use. No excuses for non-IC experimenting will be valid after this article is digested.

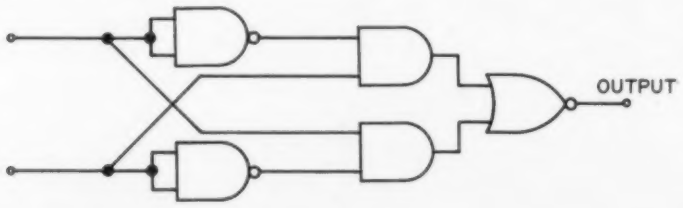
Start with a perfboard. Allow about 4" x 3" for each socket that you want. Since most ICs are 16 pins or less, I decided to design the system around these holders. Punch a hole in the board and mount the holder. Since the holders will be subject to lots of wear and tear, I spread a thin film of epoxy around each one to hold it fast. Then, on each side mount the type of solderless terminals you prefer. I used the spring type terminals. They are amazingly sturdy and the spring can keep a large number of wires very tight. Solder each terminal to its respective socket lug and you are in business.

I also mounted two LEDs to use as testers and logic tracers. If you plan to work with chips of more than 16 pins, mount them. Keep in mind that a 16 pin socket can also be used for two 8 pin chips. Mount as many sockets as you want. A TO holder may prove helpful. Feel free to customize.

For a deluxe model, mount the power supply and clock in a chassis, but instead of a metal cover, use the breadboard. Mount terminals for Vcc, ground and clock output, and another for clock speeds, and voila! A self contained IC experimenter. All you will ever need in one unit.

As your chip collection grows, a safe way of storage is needed. Try putting the chips in a soft piece of styrofoam. The pins remain undamaged and notations can be made on the styrofoam with a pen. Sometimes chips come with "house numbers" instead of the usual 7400, 7402, etc. The notations keep track of these.

Fig. 7. Two input comparator.



Don't Do Much

Readers have asked for simple schematics that teach logic even if they don't do too much. Now that the permanent breadboard is built, we can get started.

The 7400 chips are good ones to play with. Buy a few. Especially get the 7400 NAND gates, 7402 NOR gates, 7408 AND gates and the 7432 OR gate chips. This will give you the four basic gates to experiment with.

In Fig. 5 we have a circuit for a blinker. When the clock output is high the #1 LED lights. LED #2 sees low logic because the NAND gate makes its 1,1 input into a 0 output. When the clock emits a low, LED #1 stays off but LED #2 sees a high and lights. Cute, heh?

Fig. 6 is a logic probe. It's a long time favorite circuit and has been around for quite a while. (Dec. 74, *73* has another one.) It's a useful tool and *does* do much. You may want to make a permanent one. I include it because it's a good example of logic. When the probe contacts a high, LED #1 lights. For a low, LED #2 lights. The logic is simple to trace. It is similar to the blinker but it will not load down the circuit under test because the LEDs are not "seen" directly. Add this to the power supply, clock and breadboard, and you are all set.

Fig. 7 is a comparator. (Did you really think I would mention it before and not explain it now?) Its job is to compare two or more signals and if they are the same logic, give us a logic 1 output. Its logic is simple to follow. Keep in mind that it compares any similar signal 0 or 1. Instead of the NAND gates you can use the 7404 NOT gate chip. Try your hand at designing a comparator to handle more than two inputs using the two-input comparator as a building block.

If you have not already done so, try building a few of the flip flops that you have seen in the last article. They will work just as easily as these simple ones. From personal experience, I have had better luck with ICs than tubes or transistors. They are easier to trace and troubleshoot and either "work or don't work." There is usually very little optimizing and fudging as in tubes or biasing problems that you encounter in transistor circuits. And it's so much fun when the majority of your projects need only a 5 volt supply.

Please continue to write and tell us what you would like to see "explained." You are our input. ■

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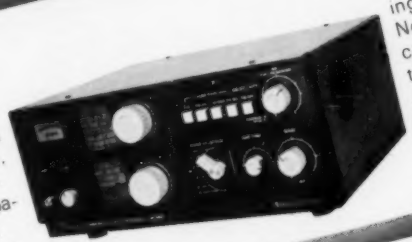

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De-Strain Your Ham-M

by
Louis Berman K6BW
1020 Laguna Avenue
Burlingame CA 94010

For the older model Ham-M Rotator, the final result is superior to the switching system presently employed in the newer model. The objective in both instances is to ease the torsional strain imposed on the rotating shaft and antenna resulting from the immediate engagement of the brake when power is removed from the rotor in the original version. This is done by momentarily delaying the brake action. The simple wiring change, together with the following instructions, should encourage even the lowest beginner to make the modification.

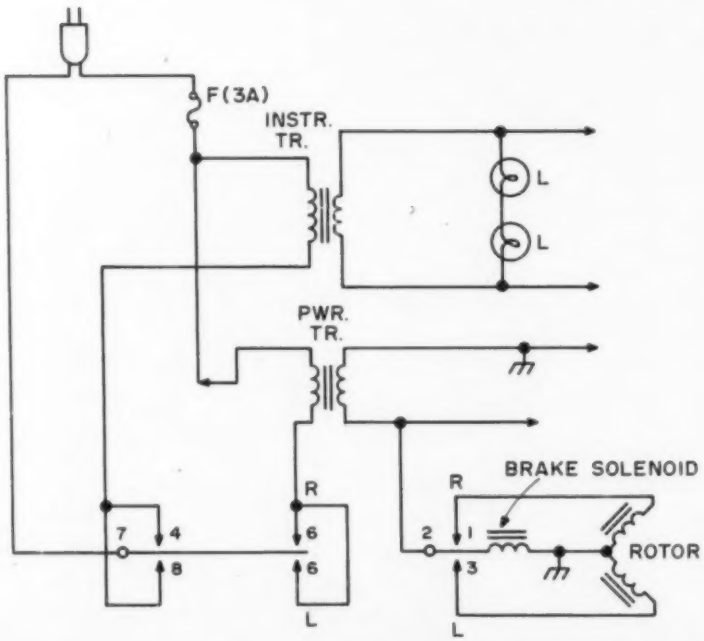


Fig. 1. Before modification.

Modification Instructions

1) Lift off bakelite housing by unscrewing the four bottom-mounting feet. Detach meter panel by removing the four screws holding it to the bottom plate. Disconnect the two meter leads. This frees the mounted bakelite component board from the meter panel bracket. Remove the meter. Unclip the two panel lamps. The control lever switch contacts are now fully exposed.

2) Screw back into position the bare panel bracket and re-mount the bakelite housing in place.

3) Drill a small hole in the bakelite panel 1 1/8" from each end of the panel front and 5/8" from the bottom edge. Pass the drill straight through each hole in a *direct line* and drill a hole in the meter panel bracket. Remove the bakelite housing and the metal bracket.

4) Enlarge the left hole in the metal panel to mount the push-button switch with the two contacts in a horizontal line. Enlarge the right hole in the metal panel to mount the miniature DPDT switch oriented so that the bat handle moves horizontally.

5) Disconnect the ac input lead from contact 7 of the lever control switch. Add about three inches and re-route the lead so that it passes to the right of the 3A fuse. Solder this lead to the left-hand contact of the push-button switch. (Control lever contacts are numbered from 1 to 8 in a clockwise direction.) Solder a wire between the left contact of the push-button switch to *both* middle contacts of the DPDT switch.

6) Remove the instrument transformer lead from contact 4 of the lever switch and solder it to the right-hand contact of the push-button switch. Leave enough lax in the wire to provide working space between the meter panel bracket and the control lever.

7) Solder a wire between the right contact of the push-button switch and one of the "on" contacts of the DPDT switch (brake out position I).

8) Disconnect the power transformer lead from contact 6 of the lever switch and solder it to the other "on" contact of the DPDT switch (brake out position I). The other primary lead of the power transformer goes to the 3A fuse, as shown in the diagram.

9) Lever contacts 4, 8, 6, 7 are not used. Contacts 1, 2, 3 remain to actuate the rotor; contact 2 also completes the brake solenoid winding circuit.

10) Check the wiring carefully and remount all parts except the bakelite housing.

Test Operations

1) Push-button momentary switch lights lamps and monitors the compass reading.

2) Double pole double throw switch is left in the "off" (brake in II) position when the unit is not in use; panel lights are off and brake is engaged to secure the rotor.

3) To rotate the antenna, snap the DPDT switch to the "on" (brake out I) position; panel lights are on and brake solenoid is actuated, releasing the brake. Moving the control lever to the left or right energizes the rotor and permits free CW or CCW rotation.

4) Release control lever just prior to reaching intended compass position, permitting the unit to coast to a full stop. Snap DPDT switch to the "off" (brake in II) position to lock the rotor and turn off the panel lights.

Housing Removal

The following steps permit lifting the bakelite housing vertically (as before):

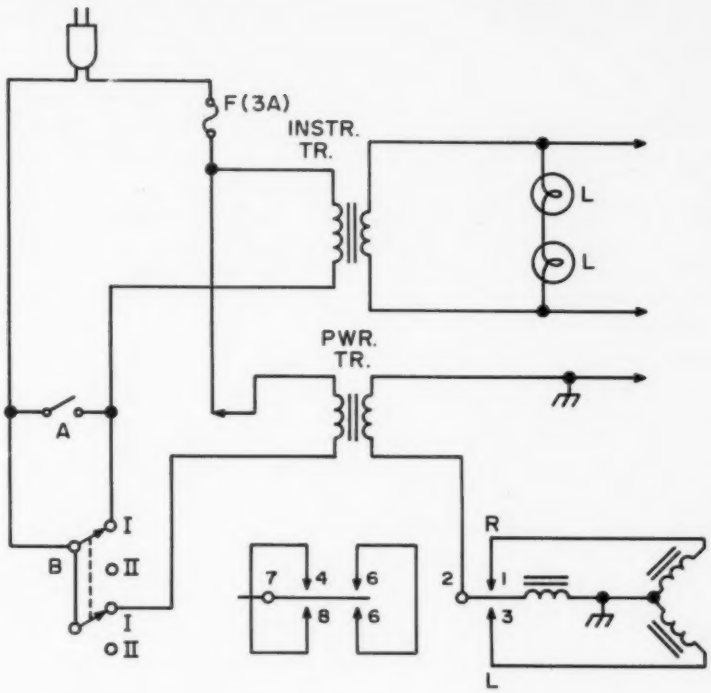


Fig. 2. A — Push-button momentary switch; B — Miniature double pole, double throw switch; I — Brake out; II — Brake in.

1) Enlarge the left hole in the bakelite housing to admit a removable hollow shaft extender to fit snugly over the button of the push-button switch. I used an old TV hollow shaft slotted at the open end, with a small knob at the other end.

2) Drill out a horizontal slit in the bakelite housing at the right-hand hole wide enough to admit a removable lever. I used a one inch length of 3/16" copper tubing, slightly compressed at one end to fit over the bat handle and flattened at the other end to facilitate lever movement.

3) Impress the following labels over the appropriate holes on the horizontal ledge above the fluting: "meter-push on" and "brake-in out" (or "brake-out in", whichever the case may be).

4) As an added refinement, mount an octal socket in the rear on one inch standoffs and permanently connect the output leads to the pins of the octal socket. The cable leads are soldered to the appropriate pins on an octal plug for easy removal of the cable.

In summary, to reverse an old adage, the entire modification is easier done than said! ■

Hot Carbon

by
John M. Murray W1BNN
4 Kenwood Circle
Bloomfield CT 06002

During World War II our military had an expression that was widely used: "to liberate" meant to help yourself, particularly if the stuff was enemy property. All too often, if not most of the time, anything attractive that belonged to someone else, enemy or not, was subject to liberation if the owner was not around or happened to be looking the other way.

I started rather young, long before the war. Someone said there's a bit of larceny in all of us. Probably W. C. Fields. Anyhow, I was coming home from school one afternoon on my bicycle when I saw a great cloud of dust rise up near our apartment building in Washington, D. C. Wreckers had just leveled an old house, which had come crashing down.

There sitting on the curbstone was the most beautiful telephone microphone I'd ever seen. It was one of the old vertical jobs with the U-hook for the receiver earpiece. A lovely bright green cord was coiled up and hung over the mouthpiece. What in the world was it doing there, I wondered.

This was no occasion to elaborately reason out that the workmen might have left it for the telephone company to pick up. It was much easier to assume they would soon fling it in their dump trucks, which were rapidly piling high with trash. Such waste would be awful.

I took a furtive look in all directions. Suddenly the beautiful microphone was no longer on the curbstone. It was under my coat, as I rapidly pedaled away.

Thus, that mike with the bright green cord began its journey into history.

A couple of years passed. My father's engineering career involved our moving several times. But wherever we went, that mike sat on the table near my radio apparatus, where I could look at it and admire it. Soon I had my ham ticket and found myself president of the Phillips Academy, Andover, Radio Club – NU1SW.

There sitting on the curbstone was the most beautiful telephone microphone I'd ever seen. Soon it was under my coat, as I rapidly pedaled away . . .

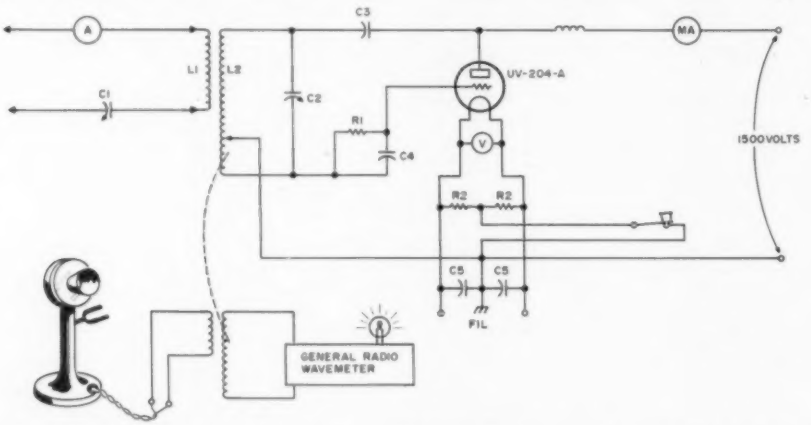


Fig. 1. 1927 Hartley circuit DX machine at NU1SW. For anyone who wishes to build this magnificent transmitter, we will be pleased to forward a list of component values and recommended hardware. Simply send us $5.00 and a copy of the New York Times *for Sunday, April 1, 1956. You will receive the information in a plain wrapper.*

(We had no official international prefixes in those days. We all had accepted an ARRL system: N signified North America and U, the United States.)

Naturally, my beautiful mike sat proudly but silently next to the CW transmitter. NU1SW's 204-A, in a self-excited Hartley circuit, had become a big deal on the 40 meter band, with about 30 countries to our credit by mid-winter, 1927. But this was all night-time stuff, mostly to be had in the wee hours of the morning. With 1,500 volts RAC on the plate at 190 mills, we were putting out enough rf in the antenna to draw a one half inch spark off the feeder wire with a lead pencil. That was a dandy way of checking the output in those days.

Well, snow was falling one Saturday afternoon, and a howling New England gale was slapping our antenna halyards against the 60-foot poles. The ham shack was nice and warm, with a banked wood fire in the iron stove. Everything was fine, but the 40 meter band was dead – just about completely, except for WIZ, which was on Cape Cod, I believe, a commercial CW outfit at the edge of our band. WIZ would send a trilogy of Vs, sign his call – and then repeat ad nauseam. This was too much!

Why not try 20 meters, which was getting very popular? We had never operated there before – or even listened on that band. My friend Gerald Marcuse EG2NM (E for Europe, G for Great Britain) had been broadcasting with voice to Australia and New Zealand around 32 meters for several years – with grand success.

It didn't take long to halve the 40 meter inductance for the rig and to change coils in our General Radio wavemeter. The capacitance of the tank coil condenser (variable capacitor to you young laddies) was fortunately okay to resonate the oscillator coil on 20, so that the wavemeter indicator bulb lit up like a stockbroker's eyes when he smells money.

The wavelength readout, as you guys might call it, was 20.9, or 14.354 MCS – Quite legitimate in those days. Antenna? It was much too cold to go outside and fiddle around. I had that one figured out, too. Hopefully. With indoor space limited to just about 16 feet in any direction, I soon had a copper wire strung up at about that length and coupled with a 250 uF condenser to a four turn coil adjacent to the plate side of the oscillator tank. Oh, boy! The contraption loaded up just fine. Backing off a bit with the antenna coil, the plate mills were steady at about 190, with the 204-A running as cool as a cucumber with the key down. Probably 125 Watts output. This was it – maybe!

Our Phillips Academy Radio Club in 1925. Only four years earlier the first amateur radio signals had bridged the Atlantic and then spread out over the globe. Between 1925 and 1929, 1SW, first with no prefix, then with U, later with NU and finally with W, was known from New Zealand to Tokyo, from London to Capetown. The school faculty, including our "advisor," who never put foot in the shack to my knowledge, had us cased as a bunch of scientific freaks. It's good to know that the W1SW boys have been doing nicely in recent years, with a more enlightened group of schoolmarms hovering in the background.

Tuning over the band at 2:25 pm, I heard no signals. So I hit the key with a CQ, slow and steady – which was top style to snag DX. Then, flipping over to receive, there was only the gentle hiss of radio silence – until suddenly, as I moved the dial across the band, a very strong signal popped up, calling us. Probably a local, we thought, until he banged out his call: EG2AO. The call book gave his location as Eastbourne, on the channel coast of England, in Sussex. And daylight nearly all the way across! "Good afternoon, old man," he CW'd at me. "Your signal's fine business. Very steady RAC, almost PDC."

After I gave him his report, he continued, "Say, old man (I was 16 years old), your signal's the best yank ever heard here, nearly as strong as WIK (a 10 kilowatt commercial station on 20.2 meters)." We had a delightful QSO, winding up by his saying, "Am now reading you on the loudspeaker. Wonderful!"

My little liberated microphone was making history, at least for us . . .

As we signed off, I found myself staring at my beautiful microphone with the bright green cord. Why not? Why not try some voice on these guys?

Having no modulator of any sort, the only answer was to make up a crude version of FM known as loop modulation. In short order I'd rigged the mike inductively to the wavemeter, which I placed near the grid end of the tank coil. But not too near. There was lots of rf floating around.

A tentative "hello test" into the mike made the wavemeter bulb flutter in sync and the plate milliammeter wiggle a few mills upward. It was a durn good thing there were no television sets around.

Now to find a guinea pig for my experiment. A CQ DX on CW brought quick response from EB4BC in Antwerp, Belgium, who reported us loud and clear. "Sure, go ahead with fone," he replied, when I told him of my wild modulation device. So I let him have it at some length, watching the little wavemeter bulb twinkling with my words.

Then I switched back to him. "You talk too fast, old man. Don't understand English well. Please say a few words in French." Fortunately I was able to comply, which brought forth an excited "fine business," with many CW exclamation points.

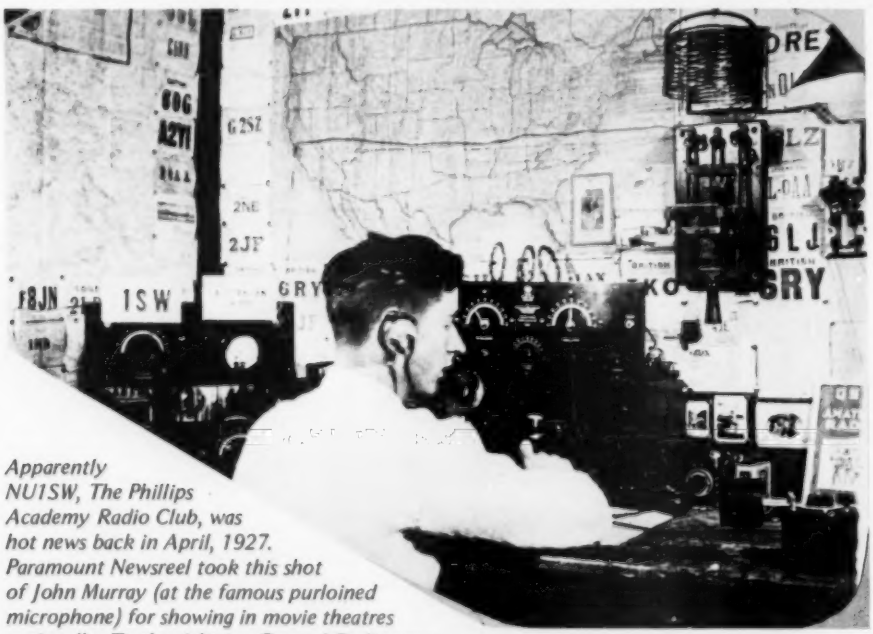
For some time I continued with him, watching the snow coming down in great sheets outside. This fone business was really fascinating -- one could say so much more in a given amount of time. Also, my little liberated microphone was making history, at least for us.

Several other club members had joined me by now. We were all amazed at our success and anxious to get some really big DX on voice. The Belgian station was about 3,400 miles away. What about Africa -- or even Australia? So we sent out a CQ DX on voice, repeating several times. "Calling Africa or Australia," I sang into the mike. It was a superb bit of optimism that had us all but breaking up.

And then, suddenly, there was F0-A3Z in Capetown, South Africa, calling us. He was on CW with a good strong signal. We'd worked him before on 40 meters. He was about 7,800 miles away. Real DX.

"Your voice loud and clear in Capetown," he said. "Congratulations. First American amateur voice signal ever heard here! Glad to work you again."

We thanked him, giving his report -- and explained what the modulator lash-up was. About then I noticed a thin wisp of blue



Apparently NU1SW, The Phillips Academy Radio Club, was hot news back in April, 1927. Paramount Newsreel took this shot of John Murray (at the famous purloined microphone) for showing in movie theatres nationally. To the right is a General Radio wavemeter. To the left is our low power transmitter, an 852 self-excited Meissner job. The cameraman insisted on hanging that crazy, obsolete switch and huge old RCA helix coil on the wall for "artistic effect." The double deck receiver lash-up has a honey coil job on top, which REL (Radio Engineering Laboratories) built especially for us, designed and donated by the late fabulous Henry B. Joy (W)8IA, 8IO, IAHM, KFKW, at that time president of the Packard Motor Car Company. Beneath it is an Aero regenerative receiver, both units battery operated, of course, since there were no ac powered sets in general use at that time.

smoke rising up from the microphone. Hurriedly we turned it back to him.

He reported everything fine up to the tail end of our transmission. "Bad distortion then set in," he said, "and your transmitting frequency really jumping around."

When I turned on once more to reply, blue smoke gushed from the mike. If this continued, the carbon grains would solidify in a ball. Quickly shutting off things, I moved the wavemeter a bit further away and detuned it slightly. Then, holding the mike by its shaft, I banged the daylights out of it on the bench.

"You're out of your mind," one of the boys said. "You're going to bust that thing."

So, I gave it a couple more whacks to show I knew what I was doing, then switched on the transmitter. "Calling F0-A3Z," I said. "Are you still there?"

"Lovely," he came back in his CW, "just lovely. But your voice much weaker now."

Then, all of a sudden, I felt as if someone had slammed me in the back of the head with a wet doormat. I began to ache all over and broke out in a cold sweat. Our 2nd op, Bob Schirmer, signed off fast with the South African. "You'd better get down to the infirmary right away," he said. "You're red as a beet."

It wasn't easy. However, he managed to help me walk the half mile and turned me over to the head nurse, Mrs. McKiver. She took one look and had me guided to a first floor bed. I never could have navigated the stairs and was by now, they reported later, not making any sense. My temperature was 105.4°. Emergency word got the school doctor on hand in jig time. He couldn't find anything wrong except my high temperature. Fortunately, it was not increasing.

Dr. Page was not noted for his sense of humor. A serious-minded little guy, he had three pet phobias: With no urging at all, he was ready at any given moment to preach on the vicious evils of tobacco, alcohol and coffee. Mrs. McKiver told me later that my greeting, when he showed up at my bedside, was hardly liable to put him in a good mood.

"Hello, sweetheart," I said. "You got a cigar on you?"

He surveyed me coldly for a moment, then raised an eyebrow. "You been drinking?"

"Sure, Doc, that's right. Maybe I need a cup of black coffee. No sugar, please."

He seemed to catch on, turning to Mrs. McKiver. "This boy's delirious. I've got to find out what he's been up to." He sat down on the edge of the bed, grasped my wrist and took out his watch. "What have you been doing today, young man?"

"Just some radio experiments you wouldn't understand – and floating out over the South Atlantic Ocean on a dreamy cloud, sweetheart, and going like hell – about 186,000 miles an hour."

Dr. Page looked at Mrs. McKiver. "Cool compresses on his forehead, please. I'll be back later." Then he prescribed a mild sedative.

In almost no time I was off in a fevered sleep which lasted for several hours. When I opened my eyes he was back again, shaking a thermometer. I was now just about normal – but with a jagged headache.

While I was floating around on my cloud, he'd been doing some hasty consulting with two other local doctors and had even called the Peter Bent Brigham Hospital in Boston. "Your trouble has something to do with radio currents," he said. "Somehow your system has absorbed a dangerous dose of these radio frequencies – giving you an artificial temperature which could have killed you if you'd gotten much more of it."

Then I explained the tests we'd made and the smoking microphone. His careful questioning brought out that my hand had been on portions of the unshielded microphone cord and also had held the shank of the telephone for an unduly long time. I'd just been overly exposed to a force I really didn't know anything about.

"I believe," he continued, "if you were about to come down with any of a number of different illnesses, you have killed the bugs, luckily not yourself to boot. A rise in temperature is nature's way of combatting unnatural intrusions and infections. In your case, there was only one bug involved, a radio bug – you. You'd better be more careful."

His advice was well taken. Dr. Page was a lot more thorough than I had imagined. It was not until several years later that the medical profession was experimenting with artificially induced radio frequency fevers to help in alleviating certain infections, notably pneumonia. A New York doctor told me that a government hospital had achieved significant results in this respect. Furthermore, it had been determined that there was a definite cut-off point beyond which the human system could not take these artificial fevers, somewhere in the neighborhood of 106°. Just a few more QSOs that afternoon would have cooked my goose, somewhat the same way that the microphone with the beautiful green cord got cooked.

So-o-o ... the next time you see a telephone with a beautiful green cord sitting on the curbstone, I suggest you leave it there. ■

All of a sudden, I felt as if someone had slammed me in the back of the head with a wet doormat . . .

Just a few more QSOs that afternoon would have cooked my goose, somewhat the same way that the microphone with the beautiful green cord got cooked . . .

EDITORIAL BY WAYNE GREEN

from page 3

to some of the restaurants ... and chew the rag about ham radio on into the evenings, drop a line or call me and let me know. The group rate is a real bargain ... runs about $150 or so for the week for the hotel and lift tickets, plus $50 for lessons, plus meals. You only live once, so get out and join a fun group for a week. Don't forget to bring an HT with 52 in it, even if you have to borrow one ... and a charger too.

When you prepay for this deal you are eligible for reduced rate air fares. From Boston it cuts the cost from $276 RT to $207 ... not bad. It'll probably give you a good cut from where you are too. Please let me know as soon as you can about this so I can make reservations. Call Wayne Green at 603-924-3873 or write c/o *73 Magazine*.

FCC – PROFOUND CHANGES

For the last few years I've felt that I was trying to shovel coal up a shute, to coin an expression which youngsters probably won't understand, having never watched coal being delivered to homes.

Amid cries from many amateurs not to rock the boat, you can't fight city hall, etc., I have been making what seemed to me to be futile suggestions about de-regulating amateur radio. When Walker wanted to go to even more license classes I sighed and filed my protest in an editorial. When Walker came up with the repeater rules I cried out in anguish and got together a group of amateurs to take the complaint to the boss: the FCC Commissioners. One of the most attentive ears at that hearing in January 1974 was now Chairman Wiley ... who seemed to be enthusiastic about the idea of freeing amateur radio from restrictions so amateurs could invent and experiment without having to file in sixteen copies, complete with a six months or longer wait.

Whether my constant nudging had any effect or not, it does appear that we are going in the direction that I have been pushing ... de-regulation ... fewer license classes instead of more ... getting rid of the growing welter of restrictions. I'm almost afraid to tell you the extent that this thing may be going. There is a strong movement deep within the FCC to set up basic guidelines ... concepts, as it were ... and then get rid of all the mass of rules.

Could you deal with a situation where all repeater rules were taken off? Where it was up to us as amateurs to make sure we have coordinating groups and that all repeaters abide by the coordinators? I wrote about this last month. This would mean that we could, if we wanted and the coordinators were in agreement, set up 10m repeaters ... crossband repeaters ... 20m to 220 MHz repeaters, etc. We could use timers on them, if we wanted ... or not.

People generally tend to group in positive or negative reactions to change ... the positive tend to view problems in terms of solutions ... the negative in terms of why you just can't do things. I suspect that should these changes come to pass that we'll have a lot of reaction of both kinds ... which will you be, a positive or a negative?

What about sub-bands? With the rules out the window we would be able to use any mode on any part of any band ... yes, I understand that this is absolutely impossible ... to answer the negatives. But perhaps with some basic guidelines it could work. It sure would be nice to be able to use SSTV and RTTY on the same frequency ... I think they'll go together well ... both can be stored on cassettes ... both work via computers, etc.

Fundamental changes such as this will take a good deal of time. Let's see if we can't be a help by thinking and talking about how we could set up a minimum regulation system which we could live with. Do we need two or three classes of license? One thing I do know, if we de-regulate substantially this will mean a lot more for the ARRL to do, for we will need to have organization to get cooperation ... and without cooperation we have only anarchy.

The FCC is not unaware of the impact of delays on licensing and they have in mind a little strategem which might help ... they may make it so that once you pass your exam you can immediately go on the air with the higher privileges. This will make it possible to hear a Novice call in the Advanced band, which might be too much of a trauma for an official observer. If they do away with sub-bands and merely set power limits for the license classes, then this might not make much difference. I do kind of like the Japanese system of letting beginners operate on all bands limited to ten Watts.

One of the major reasons the FCC is having such a time catching up with the licenses, as you know, is the backlog of CB applications. Just put on more people to handle the pileup, you suggest? Any reasonable businessman would say the same thing ... but the FCC is run by Congress and not by businessmen, and it appears that Congress could care less how much money the FCC is raking in with their CB licenses ... and the profit is enormous on them since the *only* service they provide is a piece of paper. Congress is trying to cut down on the staff of the FCC, even though every dollar saved in salary will probably cut income by hundreds of dollars. That's the Congress we all know and love.

The Commission is afraid that if the CB licenses are not promptly processed that more and more CBers will just ignore the FCC and not bother to spend the $4. In point of fact there is little reason to spend the money and Congress would do well to take advantage of the naivete of the CBers and take their money as fast and quietly as they can.

COMPUTER BIZ IN PERSPECTIVE

One of the results of my work in the microcomputer field is that I have been in contact with most of the firms producing or developing gear for this field. It has been, to say the least, fascinating.

Amateurs who are feeling twinges of inferiority because they are unable to understand the jargon should take heart. The computer biz is brand new and no one has much of a jump on you. Don't let a few buzz words drive you under the table ... when they say interface all they mean is that two things are connected together ... it's all like that and with a little reading you'll be able to go to the next club meeting, sidle up to the resident computer type and watch with glee while a growing circle of eyes pop out at your infinite knowledge.

News flash: Microcomputers are so new that hardly anyone anywhere has them working yet. If you have a few drops of pioneering blood left in you after all that appliance operating, here is a field where you have an equal opportunity.

There are some good economic reasons for getting into the field ... beyond the fun involved. In a year or so, when the pioneers in this field have systems that work, they are going to be able to sell and service them by the zillions. Experience has shown that once a home computer system is set up and running it gets used ... a lot. Kids quickly get into playing games with it and soon put the old man to shame with innovative programming. The computer gets a lot more use than television.

The really big market for them will be for business. Every small business will be using one ... and that means sales in the hundreds of thousands of units. This won't happen until the pioneers develop good working systems which are adapted to each type of business.

Most computers today are being sold directly by the manufacturers and I look for this system to fade out as truly large scale merchandising takes over. It will require local computer sales, programming and service stores to handle the growth. And who would be more logical to open such a store than the computer hobbyist of today?

...W2NSD/1

HICKOK

the value innovator

Test Instruments

Model 270 Function Generator

Sines, Squares, Triangles to 500 kHz — and much, much more

A new, versatile service and lab instrument — the feature packed Model 270 Function Generator — gives you much more waveform generating capability than you'd expect for its low price. This compact, precision unit puts stable, calibrated, high quality sine, square and triangle waveforms from 1Hz to 500kHz at your fingertips. But that's not all. With external connections you can produce logic pulses, sweeps and ramps, amplitude and frequency modulated outputs, phase and frequency shift keying signals, tone bursts, and a host of mixed signal outputs. It's even a stand-alone wideband inverting amplifier!

SINE WAVES

produced by the Model 270 are low in harmonics, stable, precise, and easy to use. With pushbutton attenuators and an output that's flat within 0.3 dB from 1 Hz to 100 kHz, the Model 270 is excellent for testing gain and frequency response of amplifiers, resonant circuits and transducers.

SQUARE WAVES

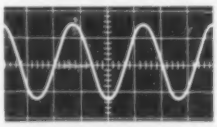
are useful for testing the response of an amplifier or other electronic device to a step change of voltage, such as rise and fall times and ringing. They are also useful for a quick check of overall bandwidth and phase shift of coupling circuits.

TRIANGLE WAVES

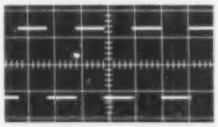
are ideal for testing the linearity of chart recorders, oscilloscopes, servo systems, amplifiers and as inputs to other devices requiring a signal with a linear change of voltage. It is easier to detect nonlinearity and clipping in an amplifier with a triangle wave than with a sine or square wave. Distortion is easier to spot, too, since gain and frequency response irregularities show up as "warpage" of the triangle's normally straight sides. The distinctive triangle shape is also easier to recognize in low level signal tracing, where sine waves often get camouflaged by hum or other sinusoidal noise sources.

Rear panel input connector allows extreme versatility

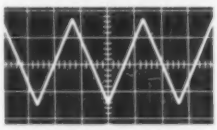
All these output waveforms, and more, can be generated by the versatile, precision Model 270 Function Generator.



Sine Wave — stable, low distortion, accurate within 1% F.S. (on a one decade dial). Amplitude flat within ±0.1 dB over entire audio range.

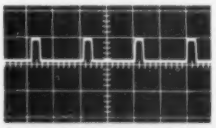


Square Wave — excellent stability, 0.5 μsec rise time, no ringing or overshoot.

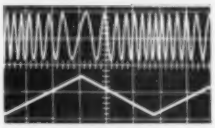


Triangle Wave — precision linearity up to 100 kHz.

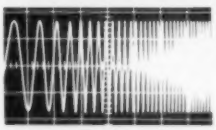
Ramps and Sawtooths — same precise linearity as triangle waves, custom shaped by you (external resistor at FSK inputs on rear panel controls fall time).



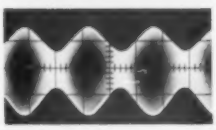
Pulses — 10 μsec TTL type shown (pulse width controlled by external resistor at rear panel. Pulse FREQUENCY, AMPLITUDE and DC LEVEL controlled from front panel.)



Frequency Modulation — sine wave (top) being frequency modulated by external triangle wave (bottom). Applicable to any basic waveform.



Swept Sine Wave — (special case of FM or VCO with external ramp applied).



AM — a 455 kHz (IF) carrier being amplitude modulated by a 400 Hz signal from a second Model 270, applied to AM input on rear panel connector.

SPECIFICATIONS:

Basic Output Waveforms: Sine, Square, Triangle

Frequency Range: 1 Hz to 1 MHz* in six pushbutton-selected decade ranges.
* Typical. 500 kHz guaranteed minimum upper frequency.

Frequency Accuracy: ± 1% of F.S. up to 200 kHz

Amplitude Flatness: ± 0.1 dB from 20 Hz to 20 kHz; ± 0.3 dB from 1 Hz to 100 kHz.

Output Level: 0 to 24 volts peak to peak (8.5 volts RMS) open circuit — protected against short circuits.

Output Impedance: 600 ohms ± 5%, constant regardless of attenuator setting.

Attenuators: Total dynamic range of step and continuous attenuators is 80 dB minimum. Step (pushbutton) attenuators provide 0 dB, −20 dB and −40 dB attenuation. (±0.5 dB accuracy) Continuous (AMPLITUDE) control provides at least 40 dB additional control.

DC Offset: Output DC level on all waveforms is variable from −6V to +6V (at 0 dB ATTENUATION)

Frequency Stability (After ½ hour warm-up):
With Line Voltage: ± 0.1% with 10% line voltage change.
With Temperature: ± 0.1% per °C from 0°C to +50°C.

Amplitude Stability (After ½ hour warm-up)
With Line Voltage: ± 0.5% with 10% line voltage change.
With Temperature: ± 0.5% per °C from 0°C to +50°C.

Sine Wave Distortion: Max. total harmonic distortion (THD) is 1% from 20 Hz to 20 kHz.

Square Wave Rise/Fall Time: 0.5 μsec or less.

Square Wave Symmetry: 95% minimum (5% maximum asymmetry).

Triangle Wave Linearity: 98% minimum (2% maximum nonlinearity) to 100 kHz.

Rear Panel Inputs: AM input, FM input, Frequency Shift Keying (FSK) control, FSK resistor, FSK Sync (Pulse/Ramp control), Mixer input.

Rear Panel Input Protection: Another Model 270 (or other unit with ± 15 volt/600 ohm output) may be connected to rear inputs without damage.

Power Required: 105–125 VAC/210–250 VAC, 50–400 Hz, 5 watts.

Size & Weight: 8½" W x 4" H x 6" D, 4 pounds.

Accessories: Rear panel connector and detailed instruction manual.

$166.00

INSTRUMENTATION & CONTROLS DIVISION
THE HICKOK ELECTRICAL INSTRUMENT CO.
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the value innovator

Model 334 Digital Multimeter

Digital Precision you can rely on . . . at a price you can afford

Carrying handle/tilt stand rotates to any position

- High accuracy — *low drift*
- Clear, *eyesaving* green display
- Fast response (2.5/sec. read rate)
- *200 mV AC/DC* ranges (100µV resolution)
- Flashing nondeceptive out-of-range indication
- Auto-polarity and decimal point
- Shielded/Isolation probe included
- *Fuseless* protection on volts and ohms

Full 3½ digit display with accuracy specified over *full-range* of readings, from 0-1999.

Here's the economical lab quality digital multimeter you've been waiting for. The Model 334 is a solid instrument through and through, backed by Hickok's 10 years of digital experience. This all-function workhorse gives you 5 ranges of AC and DC voltage and current plus 6 ranges of ohms — all with 3½ digit resolution plus automatic decimal point, automatic polarity, and automatic overrange indication.

The Model 334 virtually guides you through its measurements. For example, if a DC voltage is negative, the display tells you with a "–" before the numerical value, so you don't have to reverse the leads. And you can't get a deceptive out-of-range reading: If the input exceeds the range you've selected (maximum reading 1999), the display shows two blinking bars and three zeros (= 000, 000, = 000). There's no chance for misinterpretation.

The Model 334 is sure to be your most-used basic service tool; that's why it's designed to withstand continuous operation with an easy reading, green display to minimize eye fatigue. Isn't it time you stopped squinting at confusing analog multimeter scales? Instead, get fast, accurate, easy to read digital displays from the precision Hickok Model 334 Digital Multimeter.

$229.00

SPECIFICATIONS

DC Volts:

5 ranges: 0-199.9mV, 1.999, 19.99, 199.9, 1200 volts. Accuracy ± 0.2% of reading ± 0.1% of range (add ± 0.3% of reading for 199.9, 1200V ranges). Input Impedance: 10 megohms. Response Time: Less than 1 second. AC Rejection: 40dB at 60Hz. Input Protection: Model 334 is unaffected by overloads up to 1200 volts (DC + peak) on all ranges.

AC Volts:

5 ranges: 0-199.9mV, 1.999, 19.99, 199.9, 1000 volts RMS. Accuracy: ± 1.5% of reading ± 0.5% of range (add 1.5% of range for 199.9mV, 1.999V ranges). Frequency Response for above accuracies: 50Hz – 1KHz on 19.99V, 199.9V, 1000V. 50Hz – 250Hz on 1.999V, 50Hz – 120Hz on 199.9mV ranges. Input Impedence: 6.5 megohms/15 pf. Response Time: 3 seconds. Input Protection: Model 334 is unaffected by overloads up to 1000V (RMS + DC).

Ohms:

6 ranges: 0-199.9 ohms, 1.999K, 19.99K, 199.9K, 1.999 megohms, 19.99 megohms. Accuracy ± 0.5% of reading ± 0.1% of range (add ± 0.5% of reading for 199.9 ohms, 1.999K, 19.99 megohm ranges). Response Time: Less than 1 second. Full scale test voltage: 2 Volts. Open Circuit Voltage: 9 Volts. Input Protection: Model 334 is unaffected by 175VAC or 150 VDC all ranges.

DC Current:

5 ranges: 0-199.9µa, 1.999, 19.99, 199.9, 1999mA. Accuracy: ± 0.5% of reading, ± 0.1% of range (add ±0.5% of reading on 199.9, 1999mA ranges). Response Time: Less than 1 second. Internal Voltage Drop: 200mV max at full scale. Input Protection: 2 amp diode and fuse protection on all ranges.

AC Current:

5 ranges: 0-199.9µA, 1.999, 19.99, 199.9, 1999mA. Accuracy: ± 2% of reading, ± 2% of range, 50 – 120Hz. Response Time: 3 seconds. Internal voltage drop: 200mV RMS max at full scale. Input Protection: 2 amp diode and fuse protection on all ranges.

General:

Display: Green fluorescent, 7 segment non-blinking display, 3½ digits (0 to 1999).
Auto Polarity: Minus sign automatically indicates negative DC voltage or current. No indication on ohms or AC.
Decimal Point: Automatically positioned when range is selected.
Overrange Indication: Flashing horizontal bars and 000
Sample Rate: 2.5 readings/second.
Temperature Coefficient: 500 ppm/°C, 0-50°C
Input Isolation from Ground: 1500 volts peak.
Power Requirements: 105-125 VAC/210-250VAC, 50-400Hz, 3 Watts.
Dimensions and Weight: 8½"W x 4"H x 6"D; 3½ lbs.
Accessories: Shielded input probe with 200K isolation position included.

INSTRUMENTATION & CONTROLS DIVISION
THE HICKOK ELECTRICAL INSTRUMENT CO.
10514 Dupont Avenue • Cleveland, Ohio 44108
(216) 541-8060 • TWX: 810-421-8286

HICKOK
the value innovator

Model 511 Triggered Oscilloscope

Lab quality and performance in an economical scope

A good wideband triggered oscilloscope can be the most valuable signal tracing instrument you own for servicing TV, audio and radio equipment. On the other hand, a cheap, unreliable scope can frustrate you, lie to you and let you down when you need it most. It's your choice.

The Hickok Model 511 Oscilloscope combines economy with the reliability, ruggedness and advanced solid state circuitry.

- 10 MHz response flat within 3 dB for all signal levels. Excellent pulse response minimizes overshoot and ringing.
- Foolproof triggering to 15 MHz.
- 5 mV/cm sensitivity, very useful for solid state work.
- Bright 8 cm x 10 cm display. High 2.5 kV accelerating potential and P31 phosphor provide a clear, high contrast trace even for low repetition rate signals.
- X-Y operation for vectorscope measurements (front-panel controlled).
- Auto mode triggering provides baseline for recurrent sweep operation.
- Beam finder quickly locates off-scale traces.
- Simplified front panel controls are color coded and convenient to use. Linear potentiometers for display positioning eliminate confusion and speed adjustments. All controls are well spaced on the full-sized front panel.
- Unique VITS sync separator automatically locks on Field 1 or Field 2 VITS for video response checks.
- Viewing hood and 3-piece overlay kit included for easy circuit analysis.
- Regulated power supply maintains amplifier gain and sweep rate within 0.1% with changes in line voltage from 105 to 125 volts.
- Industrial quality and construction. Glass-epoxy PC boards used throughout.

INCLUDES COMBINATION 10:1/DIRECT PROBE
(2 WITH MODEL 512)

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HICKOK
the value innovator

Model 512 Dual Trace Oscilloscope

A value-loaded dual trace service scope with all the quality, precision and features of our single trace Model 511.

Positively the Hickok Model 512 Dual Trace Oscilloscope is the ultimate signal tracing instrument for all TV, audio and radio servicing jobs. The Model 512 has all the features of our lab quality single trace Model 511, plus the versatility of four dual trace modes.

With dual trace capability you can display either Signal A or Signal B alone, or both signals simultaneously in these dual trace combinations: Alternate A and B, Chopped (100 kHz) A and B, A plus B, and A minus B using the trace invert feature provided for each channel.

Dual trace lets you simultaneously view two waveforms that are frequency or phase related or that have a common sync voltage. For example, you can compare the input and output waveforms of amplifiers and multiple stages triggered by the same pulse; check frequency dividers; check differential amplifiers for balance; and measure amplifier phase shift and nonlinearity. If you need these added capabilities of dual trace, you'll find the Hickok 512 to be your best buy. It carries the same exceptional 2-year warranty as our Model 511 single trace as well as our 50 years of experience and reputation as a leading U.S. developer of precision test equipment for industrial and military applications.

SPECIFICATIONS: Model 511 Single Trace and Model 512 Dual Trace Oscilloscopes.

VERTICAL

BANDWITH: DC to 10 MHz, AC or DC coupled.

RANGES: 10 mV/cm to 50 V/cm in 12 calibrated steps. Uncalibrated continuously variable control operates over span from 5 mV/cm to 50 V/cm.

ACCURACY: ±3%.

POSITIONING: 3 screens.

INPUT IMPEDANCE: 1 megohm shunted by approximately 30 picofarads.

MAXIMUM INPUT VOLTAGE: 600 V DC plus peak AC.

VERTICAL MODES: (Model 512 Dual Trace): Alternate A & B, Chopped (100 kHz) A & B, A + B, A — B, A only, B only.

HORIZONTAL

BANDWITH: DC to 1 MHz, AC or DC coupled.

RANGES: Continuously variable from 0.5 V/cm to 50 V/cm with X5 expander.

INPUT RESISTANCE: 1 megohm.

TIME BASE

SWEEP RATES: 0.5 microsec/cm to 0.2 sec/cm in 18 calibrated steps. Uncalibrated continuously variable control operates over span from 0.1 microsec/cm to 1 sec/cm. 0.1 microsec/cm with X5 expander.

ACCURACY: ± 5%. Linearity better than 1% through full horizontal sweep.

TRIGGERING

MODES: Normal, auto for bright baseline.

COUPLING: TV Field (vertical), TV Line (horizontal), VITS Field 1, VITS Field 2.

SOURCE: Internal, external, line.

SENSITIVITY: Internal, ⅛ division deflection at 10 MHz to 1 division deflection at 15 MHz; External, 200 mV to 5 V peak-to-peak.

GENERAL

PROBE CALIBRATOR: Approximately 7.5 V peak-to-peak at 1 kHz.

CRT: 5-inch flat faced round with viewing area of 8 cm x 10 cm. P31 phosphor and accelerating voltage of 2.5 kV.

Z-AXIS (Blanking): Rear panel connector for display blanking by external signal.

POWER REQUIREMENTS: 105-125 V, 50-400 Hz, 35 watts regulated.

DIMENSIONS & WEIGHT: (Model 511) 10" H x 8½" W x 17" D (25,4 cm x 21,6 cm x 43,2 cm); 15 lb (6.80 kg). (Model 512) 10" H x 10½" W x 17" D (25,4 cm x 26,7 cm x 43,2 cm); 17 lb (7,7 kg).

ACCESSORIES INCLUDED

Combination 10:1/direct probe(s) 1 with 511, 2 with 512, Viewing Hood and Overlay Kit: TV Field; TV Line; VITS Field 1; VITS Field 2; Vectorscope.
Instruction Manual

PRICES (August 1974)

511 Single Trace 10 MHz Oscilloscope	**$485.00**
512 Dual Trace 10 MHz Oscilloscope	**675.00**

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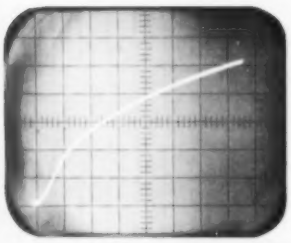
Model 440 Semiconductor Curve Tracer Featuring Exclusive INSTA-BETA display

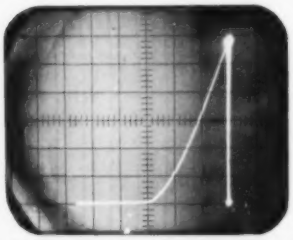
$165

There's no faster, more accurate way to test semiconductors in or out-of-circuit than with the Model 440. It generates instant scope displays showing the exact performance of any diode, transistor or FET over its entire operating range. From these actual characteristic curves you can quickly test, identify, evaluate, classify and match devices . . . find substitutes . . . troubleshoot defective modules on the bench or production line . . . and design circuits to tighter performance specifications. In industry, it's invaluable for checking and sorting incoming bulk stocks and for on-line testing, quality control and final inspection (even unskilled operators can be trained in minutes to make specific tests with the Model 440). Service and lab technicians, electronics instructors and hobbyists will welcome the versatility, accuracy and ease of operation of this instrument. In short, the Model 440 is an extremely versatile design, inspection, troubleshooting and teaching aid.

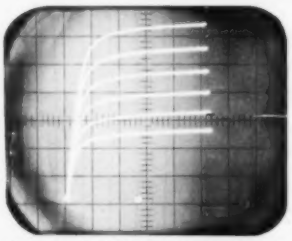
- Exclusive INSTA-BETA mode permits direct measurement of transistor DC and AC Beta
- Displays FET transfer characteristics showing V_P, I_{DSS}, and Gm in a single curve (INSTA-BETA mode)
- Variable step control for 1 to 10 steps
- Horizontal V/DIV control — no recalibration needed to measure diode drops accurately
- Easy to set up and operate — handy pull-out card gives ready reference information for calibration, set-up and operation
- Automatic current limiting
- Compatible with all scopes having external horizontal input (DC coupled scope recommended)
- Fast set-up marks for 80% of tests



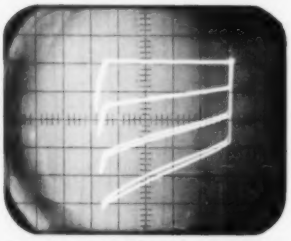
INSTA-BETA display — this single, continuous I_C/I_B display lets you instantly calculate DC and AC Beta at any point, shows Beta linearity at a glance (NPN curve shown).



Full range transfer curve shows the pinch-off point, full-on current and entire active portion of an N-Channel FET (INSTA-BETA mode).



Standard (NORMAL) display of a Good N-Channel FET.



Standard (NORMAL) display of a PNP transistor showing breakdown.

SPECIFICATIONS

TYPES OF DISPLAY:

NORMAL — I_C/V_{CE} at steps of I_B for transistors
— I_D/V_{DS} at steps of V_G for FET's
— I/V for diodes

INSTA BETA — I_C/I_B at constant V_{CE} for transistors
— I_D/V_{GS} at constant V_{DS} for FET's

COLLECTOR/SWEEP SUPPLY

VOLTAGE: Continuously variable from 0 to 100 volts peak (with tapered control for easy setability at low voltages)

CURRENT: Up to 100 mA peak with automatic current limiting at approximately 130% of full scale (10 DIVS)

FREQUENCY: 120 Hz (2 x line frequency)

BASE/GATE GENERATOR

NUMBER OF STEPS: Variable from 1 to 9 steps minimum.

CURRENT: (NORMAL) 11 ranges from 1 μA/step to 2 mA/step; ±5%
(INSTA-BETA) 11 ranges from 1 μA/DIV to 2 mA/DIV; ±5%

VOLTAGE: (NORMAL) 11 ranges from 1 mV/step to 2 V/step; ±5%
(INSTA-BETA) 1 V/DIV; ±5%

CALIBRATION

VERTICAL: 0.05, 1, 2, 5, 10 mA/DIV ±5% with scope set to 0.1 V/DIV

HORIZONTAL: 1, 5, 10 V/DIV ±5% with scope set to 1 V/DIV (built in calibration for setting scope vertical and horizontal)

MISCELLANEOUS

SOCKETS: Two sockets each paralleled by banana jacks for external leads (sockets are plug-in type for easy replacement).
Three position slide switch selects either socket set or OFF

ACCESSORIES: Cables to scope and instruction manual

POWER REQUIRED: 105-125 VAC/210-250 VAC, 50-60 Hz

DIMENSIONS: 8¾" W x 4⅝" H x 7½" D

WEIGHT: 4½ pounds

INSTRUMENTATION & CONTROLS DIVISION
THE HICKOK ELECTRICAL INSTRUMENT CO.
10514 Dupont Avenue • Cleveland, Ohio 44108
(216) 541-8060 • TWX: 810-421-8286

HICKOK
the value innovator

Model 220 Deluxe In-Circuit Semiconductor Analyzer

Now! Troubleshoot Solid-State Circuits Without Your Soldering Iron

$298.50

(EZ Hook Leads included)

- In or out of circuit tests on all types of semiconductors.
- Automatic nulling.
- Two modes of operation: GOOD/BAD test or PARAMETER measurement.
- GOOD/BAD operation provides:
  Automatic lead and polarity selection.
  Bright LED display for fast and easy GOOD/BAD indication and lead identity.
- PARAMETER operation provides:
  Beta or FET transconductance measurement, on three meter ranges, in or out-of-circuit.
  Automatic Beta and transconductance calibration for one step operation.
  In-circuit resistance measurement, using low voltage, unaffected by semiconductors in the circuit.
  Leakage measurement for diodes or transistors out of circuit.
- Storage for test leads and line cord under hinged top cover.

SPECIFICATIONS

Ranges and Functions:
Beta: 1-100, 10-1000, 100-10,000
(Beta test collector current-1 mA)
Ohms: 100 ohms, 1K ohms, 10k ohms Center Scale
FET: 0-250, 2-2500, 0-25,000 Gm
I_F, I_R: 0-10μA, 0-100μA, 0-1mA
(used for leakage tests, and SCR, UJT, TRIAC tests)
Diode: Qualitative with ≥ 500 ohms parallel load
SCR, UJT, TRIAC: ON/OFF Current (qualitative)

Accuracies:
Beta: ±5% of arc, in or out of circuit except highest β range = 30% of arc in-circuit (≥ 500 ohms in parallel)
Ohms: ±3% of arc in/out-of-circuit
Gm: ±5% of range out-of-circuit, ±15% of range in circuit (≥ 100 ohms G-S, 4k ohms D-S)
I_F, I_R: ±5% range, out-of-circuit

Power Requirements:
105 to 125 V, 50-400 Hz or 210 to 250 V, 50-400 Hz

Size:
8" W x 7" H x 6" D
Weight 6¼ lbs.
Low level output will not damage semiconductors or circuits.

The Hickok Model 220 is a truly active, in-circuit measuring device that is completely automatic. The 220 automatically nulls out the in-circuit loads. It even indicates the proper leads for you.

The 220 is not just another transistor tester made up of pots and resistors. It contains active solid-state devices consisting of integrated circuits and operational amplifiers that remove all guess work. There is no need to search for data sheets and no need to unsolder components. It does a rapid test on all types of semiconductors both in circuit and out of circuit.

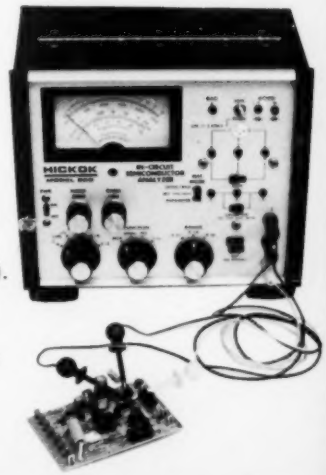
The Model 220 has two modes of operation that make it essentially two instruments in one.

1. GOOD/BAD test
2. PARAMETER operation

Good/Bad operation automatically determines lead configuration and device polarity and bright LED displays give positive Good/Bad indication and identify device leads.

Parameter operation measures transistor Beta or FET transconductance either IN or OUT of circuit with three meter ranges. Automatic Beta and transconductance calibration are fast and easy one-step operations.

1. Connect leads in any order – Model 220 instantly performs GOOD/BAD test (see Model 215 for details).
2. SET BASE switch to position indicated by LED.
3. SET function switch to TYPE (N or P) indicated by LED.
4. Measure BETA (in-circuit).
5. Set COLLECTOR switch for max. beta reading.
6. Model 220 now indicates:
   – GOOD/BAD
   – BASE lead
   – Type (N or P)
   – Collector lead
   – Beta



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Model 215 Pocket Semiconductor Analyzer

It's Fully AUTOMATIC

$138.00

Includes convenient
E-Z Hook leads for in-ckt tests

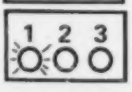
Why this time saver is the choice of the experts . . . in computer, industrial, and consumer servicing as well as field and lab maintenance.

- **Automatic, "hands-off" operation – frees both hands for trouble-shooting.**
- **Instant GOOD-BAD analysis – including LEAKAGE – of NPN's, PNP's, FET's, diodes & SCR's; in or out-of-circuit.**
- **Rugged, all solid state – no moving parts.**
- **Compact polypropylene case – 5-3/4"H x 3-3/8"W x 1-7/8"D; 12 oz.**
- **Will not damage transistors, diodes, or circuits under test.**
- **Powered by 2 std. 9V batteries (not incl.) for go-anywhere portability. (Recharger – P/N 20800-421 – available for use with nickel-cadmium batteries).**
- **Low-power CMOS design for extended battery life.**

Digital scanning circuit does all the switching

1. Signal is applied to the device under test.
2. Rectified signal is detected and stored in memory.
3. Internal scanner sequences through all possible lead configurations in **1 second!**
4. If the device is good LED indicates polarity and "GOOD"

   . . . as well as the Base (gate for FET's)



5. Open, shorted, or leaky device flashes "BAD"

6. Test cycle repeats every 4 seconds.

What about LEAKAGE? **– It's automatic too!**
. . . and *in-circuit!*

- Valid in-circuit tests can be made with as low as 500 ohms (150 for GE) in parallel with the device under test.
- This means that a lower impedance – whether due to leakage or circuit impedance – is analyzed as leakage and indicated as "BAD." If a device reads "BAD" in-circuit, it should be rechecked out-of-circuit to insure that circuit impedance did not cause the "BAD" indication.
- This designed-in impedance limit allows rapid detection of most leaky devices . . . even in-circuit. *Such leaky devices often escape detection* with other testers unless extra, out-of-circuit tests are also performed.

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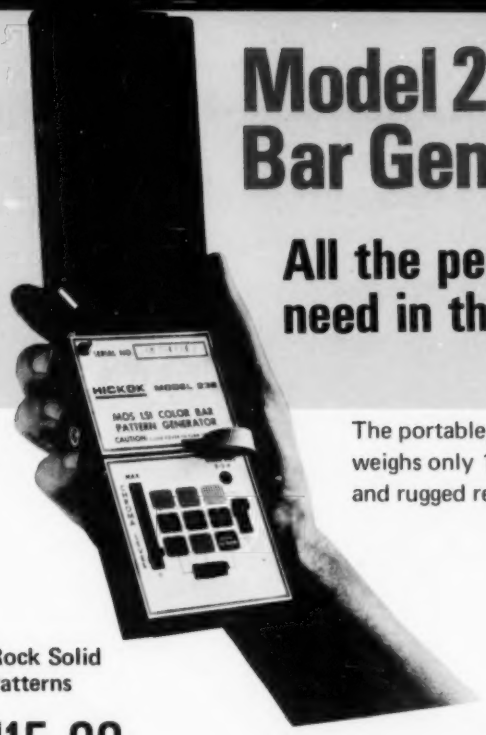
Model 239 Pocket Color Bar Generator

All the performance features you need in the palm of your hand.

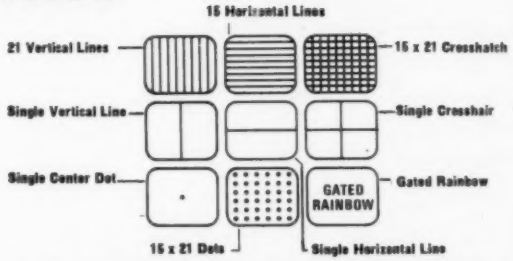


Rock Solid Patterns

$115.00

The portable, battery operated Model 239 Pocket Color Bar Generator weighs only 12 ounces, yet we've engineered into it industrial performance and rugged reliability. Here are its features:

- Small size, light weight design – only 5-3/4" x 3-3/8" x 1-7/8" (fits jacket pocket), 12 ounces
- Exclusive Hickok-developed MOS LSI IC provides these unique advantages: low component count for high reliability . . . extremely low battery drain . . . rock-stable signals from –50° to +150°F; all digital timing circuits for solid pattern stability . . . and small package size.
- Simplified controls. Two matrix slide switches select any of the nine patterns.
- Chroma level adjustable from 0–150% for bright, sharp patterns.
- RF adjustable, Channels 2–4.
- Crystal controlled chroma and timing oscillators.
- Powered by two standard 9V batteries. (not included)
- Rugged polypropylene case.
- Recharger – P/N 20800-421 – available for use with nickel cadmium batteries.



only our unique MOS LSI circuitry can give you these nine, stable, FCC-Specification signals in so small and rugged a unit.

Model 246 Deluxe Color Bar Generator

same solid stability as our Model 239 plus additional capabilities!

$187.50

16 Stable Patterns

It has everything you ever wanted. It does everything you'll ever need. The small-cube Model 246 Deluxe Color Bar Generator with advanced solid state circuitry provides 16 stable patterns including a gated rainbow for testing/aligning color circuits. Its three gun killers with piercing clips let you selectively kill the red, blue and green gun grids in the set you're testing. There's even a handy storage compartment for cables, leads and line cord.

Compare these features:

- Exclusive Hickok-developed MOS LSI IC provides digitally controlled stable patterns from –50° to +150°F. The lower component count with this IC also increases overall reliability and permits a smaller package size.
- A full 16 patterns gives maximum versatility and minimum distraction when making critical checks and adjustments.
- Chroma level adjustable from 0-200% for bright, sharp patterns.
- RF adjustable, Channels 2-4.
- Crystal controlled chroma and timing oscillators.
- Gun killers are switch-selectable from front panel; leads and piercing clips provided.
- Adjustable dot size.
- Video output, ± 3V peak-to-peak.
- Horizontal and vertical oscilloscope triggering outputs.
- Dimensions: 8½"W x 4"H x 6"D; 4 lbs.
- Power Required: 105-125VAC, 50-400 Hz, 1 watt.

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the value innovator

Model 350
Pocket FET Multimeter

FEATURES

- Full VTVM type ranges and 10 megohm input impedance in a pocket size unit
- Foolproof overload protection
- True Auto Polarity, with polarity indicator
- Hi/Lo Ohms
- One year battery life plus battery test circuit
- Compact, lightweight, rugged case with attached cover
- Mirrored scale for 1 millivolt accuracy
- Simplified quick-reading meter; 3 scales plus dB & Batt condition.

Complete with 2 compact test leads and instruction manual . . .

$119.00

Hickok Instruments is proud to announce an addition to its family of precision pocket instruments designed specifically for the service technician. It combines bench top accuracy in a truly portable package for troubleshooting sensitive solid-state circuits in the field.

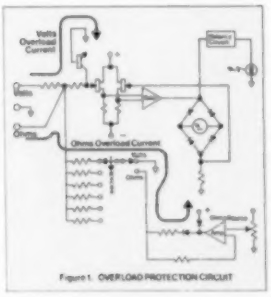

Figure 1. OVERLOAD PROTECTION CIRCUIT

The Hickok Model 350 FET Multimeter is a very accurate, high impedance, full-function multimeter with an easily read, proven Hickok meter movement. The multimeter is protected by a special solid state circuit which not only prevents burn-out but also precludes damage to the movement caused by pegging" the meter on overloads. As the schematic in Figure 1 shows the meter "sees" only the output of the op-amp and therefore cannot be overdriven. In order to prevent component burn-out overload current is shunted through a load resistor thus allowing the excellent overload limits without fuses or resetting.

True Auto-Polarity is provided by the bridge network of which the meter is a part. Negative polarity is indicated by a flashing LED.

VTVM-Type ranges provide AC or DC voltage measurement on 9 ranges from 0.1 to 1000 volts fullscale. The mirrored meter scale is a long 2.4 inches over an 80° arc providing 1 millivolt resolution on the 0.1 volt scale.

Hi/Low Ohms ranges allow in-circuit resistance measurement in solid state circuits as well as conventional front to back ratio tests.

One year of normal operation can be expected from two 9 volt transistor radio batteries. Battery condition is readily checked with the built-in battery check-circuit which measures the batteries under load.

All these features are wrapped up in a pocket-size polypropylene case with an integral cover which snaps shut to protect the meter face and controls.

VTVM Accuracy In Your Pocket

SPECIFICATIONS

DC volts, 9 ranges
0.1, 0.3, 1.0, 3.0, 10, 30, 100, 300, 1000
Accuracy: ± 2% of full scale
Input Impedance: 10 megohms

AC volts, 9 ranges
0.1, 0.3, 1.0, 3.0, 10, 30, 100, 300, 1000
Accuracy: ± 3% of full scale @ 60 Hz
Frequency response: (± .5 dB) 50 Hz to 5 KHz
except .1, and .3 ranges 50 Hz to 400 Hz
Input Impedance: 10 megohms/30 pf

Ohms – 7 Hi/Lo ranges
100, 1000, 10k, 100k, 1M, 10M, 100M, center scale
Accuracy: ± 3% of arc (no 100 Hi range)

Decibels: –50 to +62 (0 dB = 1mW into 600 ohms)

Overload protection:
Ohms ranges – 115V AC/DC continuous,
230V AC/DC for 3 seconds
AC volts ranges – 1000V AC/600 DC except
.1, .3 ranges – 250V AC/DC
DC volts ranges – 1000V AC/DC except
.1, .3 ranges – 250V AC/DC

Power requirements: 2 Standard 9V transistor batteries – NEDA 1604 (not incl.)

Battery life (typical): 100 hrs. continuous 200 hrs. intermittent
1 yr. @ 2hr./day – 5 day/wk.
Dimensions: 5-3/4" x 3-3/8" x 1-7/8"
Weight: 14 oz.

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the value innovator

Model 370 Deluxe FET Multimeter

FEATURES

- **Capacitance measurement from 500pf to 10,000μf**
- **True Auto-Polarity with indication**
- **Rugged overload protection**
- **Hi/Lo Ohms**
- **Easy-to-read 5½" meter with mirrored scale**
- **Only 3 scales for most measurements**

$175.00

More than just a solid-state VTVM

The Model 370 is a versatile solid-state, auto polarity multimeter capable of measuring a wide range of DC volts, AC volts, DC and AC current, resistance and *capacitance*. The 370 uses the latest in state-of-the-art FETS, IC's and CMOS devices. Field-effect transistors are used to achieve a high input impedance (10 megohms on AC and DC volts). The input impedance is constant regardless of range selected. The large meter scale is divided and color-coded for easy reading: two arcs for V and mA, and one for ohms, plus one for capacitance, one for dB, and two for P-P volts.

The Ohmmeter function utilizes an operational amplifier supply eliminating the cost and nuisance of batteries. When the Hi/Lo switch is in the Lo ohms position resistance measurements can be made in networks containing solid-state junctions without forward biasing the junctions. In the Hi-ohms position the ohmmeter may be used for junction testing.

Frequency response of the 370 is useable from 20Hz to 50kHz. This is an excellent instrument for measuring voltages in AC amplifiers. On DC measurements the isolating resistor is located inside the unit, thus eliminating the need for a third lead or troublesome switch in the probe. The built-in isolation resistor makes DC voltage measurements in RF amplifiers and oscillator circuits possible.

Capacitance function is a plus feature for service work. Six ranges of capacitance allow measurement from 500 pF to 10,000μF. Ranges are such that approximate center scale values are from 0.005μF to 500μF.

Pushbutton ranges and functions allows fast selection without going through unwanted ranges and functions.

Auto-polarity means there is never a need to change leads or even a polarity switch. This also eliminates any need for a zero center scale. An LED lamp glows steadily when measuring positive volts or current and blinks when measuring negative volts or current.

Specifications:

DC volts: ± 2% of full scale, 9 ranges
0.15, 0.5, 1.5, 5.0, 15, 50, 150, 500, 1500 volts
Input Impedance: 10 megohms

AC volts: ± 3% of full scale, 9 ranges
0.15, 0.5, 1.5, 5.0, 15, 50, 150, 500, 1500 volts
Frequency response: ± 5% of full scale @ 20Hz–20kHz
Input Impedance: 10 megohms/40pF

Ohms: ± 3% of arc, 8 Lo ranges, 7 Hi ranges
10, 100, 1K, 100K, 1M, 10M, 100M center scale
Lo Ohms = 150mV open circuit
Hi Ohms = 1.3V open circuit (no 10 ohm range)

DC Current: ± 3% of full scale, 9 ranges
0.15, 0.5, 1.5, 5.0, 15, 50, 150, 500, 1500mA
150mV F.S. drop + 2 ohms across input terminals

AC Current: ± 4% of full scale, 9 ranges
0.15, 0.5, 1.5, 5.0, 15, 50, 150, 500, 1500mA
Frequency response: ± 5% Full Scale 60Hz–1kHz (useable to 20kHz)
150mV F.S. drop + 2 ohms across input terminals

Capacitance: ± 3% of arc, 6 ranges
.005, .05, 15, 5, 50, 500 μF
(500pF to 10,000 μF capability), calibrated at 60 Hz Line.

Overload protection:
DC and AC volts – 1500 volts rms all ranges
DC and AC current – rear panel fuse all ranges
Ohms and Capacitance – rear panel fuse all ranges

Power requirements:
105-125VAC/210-250VAC, 50-400 Hz, 3 watts

Dimensions and wt: 8¾"W x 7"H x 6¾"D, 4¾ lbs.

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the value innovator

Model 265 Portable CRT Analyzer/Rejuvenator

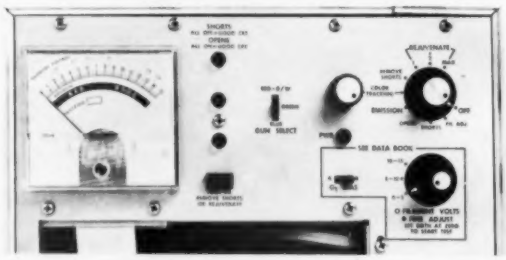
Fast, Easy to Use, Accurate. Helps Sell You to Your Customers.

includes 13 plug-in sockets and comprehensive CRT Troubleshooting Chart

$277.50

The Hickok Model 265 is the easiest-to-use CRT Analyzer/Rejuvenator there is for fast in-the-set testing, repair and rejuvenation of all black and white and color CRT's — in your customers home — including the new in-line color TV types. Check the following service-oriented features and you'll find the Model 265 will mean customer satisfaction and more profits for you:

- Rugged, lightweight portable is ideal for on-the-job testing and rejuvenation or repair of faulty picture tubes. Large rectangular meter with 3 simplified scales completely tests any CRT. It helps sell your customers, because they can actually see the condition of their TV tube.
- A full 13 self-storing printed circuit card sockets plug interchangeably on the end of a single flat flexible cable. No floppy harness assemblies to handle and no broken wires to cause baffling measurement problems. Sockets for any future base configurations easily developed.
- Filament protection circuit prevents accidental destruction of CRT's. Filament voltage must be set to zero before filaments can be lit. Voltage is infinitely variable from 0 to 15 volts with common values specially marked on meter. Obsolescence proof.
- Easy setup of G1 and automatic setup of G2 and cutoff provide the simplest emission test in the industry. Color coded GOOD/BAD indication on meter leaves no doubt in customer's mind.
- Sensitive but fast tracking test assures that color guns will have proper gray scale tracking when TV is put back in operation.
- Three high-brightness neon tubes provide rapid detection of inter-element shorts, leakages, and opens in the CRT.
- Shorts or leakages may be cured by placing FUNCTION switch in REMOVE SHORTS position and pressing REMOVE SHORTS/REJUVENATE switch.
- Three switch-selectable levels of REJUVENATE permit tailoring treatment to the condition of various CRT's. MAX REJUVENATE setting applies a high voltage discharge that may also cure opens by welding broken internal connections.
- All solid state circuitry with rugged glass-epoxy PC boards, means long trouble free performance.
- Power requirements: 105-125V or 210-250V, 50-400 Hz.
- Size: 11¼ x 9½ x 5¾; Weight: 7½ lbs.

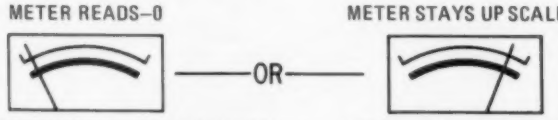


Fast Set-up — **even checks filament continuity! . . . without extra steps.**

1. Set Function switch to OFF, Filament switches to O.
2. Set G-1 bias switch, connect socket to cable.

   [Meter reads upscale indicating no CRT connected]

3. Connect socket and cable to CRT.



4. Adjust filament to proper voltage.
5. Rotate Function switch to test SHORTS, OPENS, EMISSION, TRACKING.

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Model 230 Solid State Dynamic Emission Tube Tester

The last tube tester you'll ever need!

Note these outstanding features:

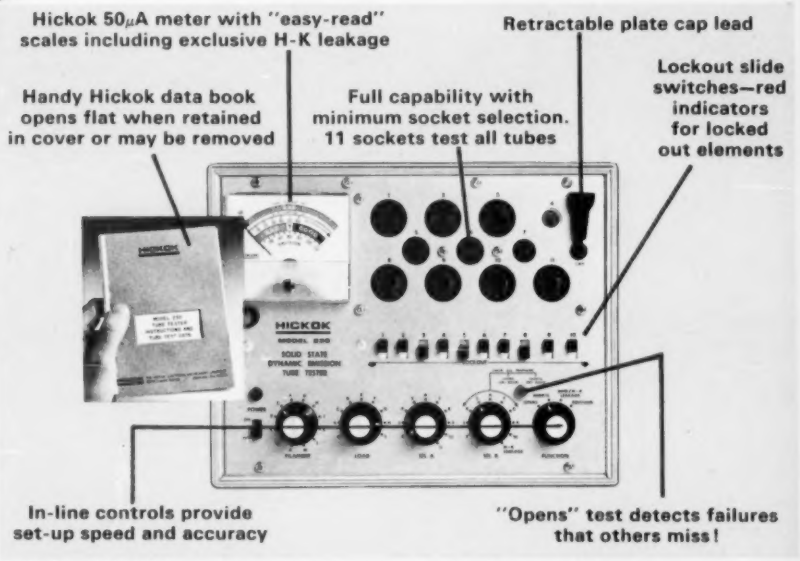
- **Opens test for all elements** *a Hickok exclusive*
- **Directly metered H-K leakage test, 2μA sensitivity, impossible with neon leakage tests**
- **True test for shorts, any combination of elements may be locked out**
- **50μA Hickok meter—permits direct reading of grid leakage and H-K leakage**
- **Lifetime serviceability, designed in with easily replaced standard sockets and components**

Plus these standard features you require for critical service testing:

Fast 5 step in-line control setup
Cathode emission tested under rated load
All solid state design
Portable rugged attache-case styling

Tests for all the new and old tubes including Nuvistors, Novars, Magnovals and the new 10 Pin Tubes and 12 Pin Compactrons are contained in the self-retaining and removable data book.

$155.00


Hickok 50μA meter with "easy-read" scales including exclusive H-K leakage
Retractable plate cap lead
Lockout slide switches—red indicators for locked out elements
Handy Hickok data book opens flat when retained in cover or may be removed
Full capability with minimum socket selection. 11 sockets test all tubes
HICKOK
In-line controls provide set-up speed and accuracy
"Opens" test detects failures that others miss!

HICKOK, **the quality name** in tube testers, presents the tube tester designed to be used day in and day out for a lifetime of service.

Designed to meet the wear and tear of everyday use, this instrument is easily maintained and updated. All sockets, switches and components (except meter and transformer) are mounted on a single glass-epoxy p.c. board for ruggedness and ease of maintenance. No riveted sockets. The Hickok 230 tube tester can be maintained in new condition with minimum time and expense. The life of **this** tube tester won't end with the failure of a tube socket!

The Hickok Model 230 tube tester offers the critical tests necessary to handle the problem sets you face each day.

The 50μA Hickok meter permits direct reading of heater-cathode leakage to spot hum and other isolation problems. We've also included a directly metered grid leakage test to find problems in the AGC, SYNC or CHROMA sections which depend on high grid circuit impedance. If a tube has a short **or** an open you'll find it quickly with this tester. Ten slide switches let you lock out any or all elements to get rid of normal shorts. With all these tests the setup is a simple 5 step in-line process, with minimum socket duplication to avoid confusion and errors.

To assure the lifetime service of this equipment "new tube" sheets will be available from The Hickok Electrical Instrument Company, the value innovator with the 2-year warranty.

Dimensions	11¼ x 9½ x 5¼
Weight	5¼ lbs.
Power	105-125V or 210-250V, 50-400 Hz

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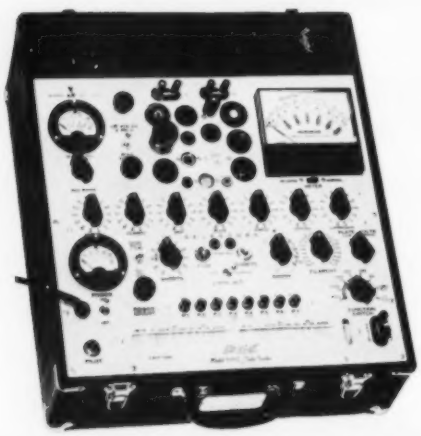
Hickok Mutual Conductance Tube Testers



Model 539C Industrial and Laboratory Portable Tube Tester

- **Six micromho ranges.**
- **Complete check of voltage regulator types.**
- **Four AC signal voltages.**
- **Dual tube leakage readings, directly on meter or by neon short indicator.**
- **Provides for plate current and heater current measurement.**

SPECIFICATIONS

Tube Sockets: 4, 5, 6, 7-pin, octal, loctal; 7, 9, and 10-pin miniature; 7-pin in-line and 8-pin round sub-miniature; Compactron; Novar; 5 and 7-pin Nuvistor. Socket Savers furnished for 7-pin and octal sockets.

G_m Ranges: 600, 3,000, 6,000, 15,000, 30,000 and 60,000 micromhos. Also, rectifier diode and voltage regulator ranges.

Inter-element Leakage: Indicated directly on meter or on neon lamp. Sensitivity to 50 megohms.

TEST VOLTAGES:

Filament: 0-117 volts AC in 19 steps.

Signal: 0.25, 0.5 and 2.5 volts RMS.

Plate: 66 and 150 volts DC.

Screen: 56 and 130 volts DC.

Fixed Bias: 0 to −40 volts DC, continuously variable.

Self-Bias: Through terminal arrangement on front panel.

Meters: Three meters with 1% accuracy.
G_m meter with 6 ranges; scales to 200 volts for VR tube testing and to 50 megohms for leakage testing.
AC-line voltage meter.
DC voltmeter (0-10 and 0-50 scales) to adjust negative grid bias.

Power Requirements: 115/230 volts, 50-400 Hz, 40 watts.

Dimensions: 7-1/2"H x 16-3/4"W x 18-3/8"D. 28 pounds.

$895.00

Model 6000A Service Technicians' High Speed Portable Tube Tester

- **Sensitive instantaneous inter-element leakage and shorts test.**
- **Constant indication of line voltage.**
- **Filament continuity test.**
- **True mutual transconductance test.**

SPECIFICATIONS

Tube Sockets: Furnished with type RSP-5, 8-socket removable plate to accommodate octal; 7, 9 and 10-pin miniature; Compactron; Novar; 5 and 7-pin Nuvistors. Worn tube sockets replaceable.

G_m Ranges: 3,000, 6,000 and 15,000 micromhos, read directly on 3-scale meter.

Inter-element Leakage: Registers instantly on 5 neon lamps, identifying elements involved. Sensitivity in excess of 3 megohms.

Filament Voltages: 1.5 to 50 volts in 16 steps.

Grid Current (gas) Test: Measured in microamperes of grid current on meter when button is pressed. Presence of gas disclosed.

Filament Continuity Test: Open filaments can be discovered immediately after tube is inserted in socket by pressing control button.

Power Requirements: 115/230 volts, 50-70 Hz, 30 watts.

Dimensions: 7-1/2"H x 16-3/4"W x 11-3/4"D. 16 pounds.

$475.00

Model 890A Dynamic Beta In-Circuit Transistor Tester

- **Unique impedance neutralizing circuit measures AC Beta accurately in or out of circuit.**
- **Measures following in-circuit parameters: AC Beta, transistor input resistance, base-emmiter circuit impedance, I_c.**
- **Measures AC Beta, I_c and I_{cbo} out of circuit.**

SPECIFICATIONS

I_{cbo} Measurement Range: 0 to 50 microamperes.

Beta Ranges: 0-50, 0-100, 0-200. Accuracy: ± 5% for circuit impedance above 150 ohms.

Collector Test Current: Variable, 0 to 10 milliamperes.

Collector Test Voltages: Variable, 1.5 3 and 4.5 volts.

I_c Range: 0 to 10 milliamperes.

AC Test Signal: Variable 1000-Hz sine wave. Calibration setting at 5-microampere base current.

Transistor Input Resistance Range: 50 to 10,000 ohms.

Circuit Input Impedance Range: 100 to 100,000 ohms.

Batteries Required: One 22.5-volt; four 1.5-volt batteries.

Dimensions: 6-1/2"H x 10-3/4"W x 9"D. 7-3/4 pounds.

$235.00

INSTRUMENTATION & CONTROLS DIVISION
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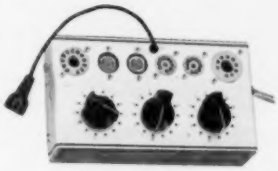
MODEL	DESCRIPTION
SP-5	Oscilloscope Probe — combination 10:1/Direct. for use with Models 511 and 512. P/N 100-178 $29.95
TP-3	E-Z Hook test lead set, for use with Models 215, 220, 440 or other applications where high density circuits are encountered. Set includes 3 color coded leads with banana jack. P/N 12450-463 $5.95
TP-4	Tri-contact probe for in-circuit transister testing. For use with Models 215, 220 and 440. P/N 16970-111 (not shown) $16.50
VP-7	Shielded test probe set with switchable 100K isolation or direct operation. For use with Models 334 and 370. P/N 16970-112 (not shown) $9.95
RC-1	Recharger. For use with nickel-cadmium batteries (Eveready N88) on Models 239 and 215. P/N 20800-421 $6.25
CA-5	Universal adapter for modernizing older Hickok tube testers. Contains sockets for 5 and 7-pin Nuvistors, Novars, Compactron and 10-pin tubes. Current set-up data included. For use with Models 533A, 539B, 600A, 605A, 750, 752, 800, 1575, 6000, 6005 and Cardmatic testers. 1-1/2"H x 7-1/2"W x 4"D. 1-1/2 pounds. P/N 1050-164 $75.00

SP-5

TP-3

RC-1



CA-5

Additional Accessories

(Available from our Factory Service Dept.)

		PART NO.	APPLICATIONS: 6000A	539C	Order Types
	TUBE TEST ADAPTERS				
CRT-1	Picture Tube Adapter for Tube Testers (B/W Only)	1050-114	X		
RSP-4C	Accessory Socket Assembly for Mod. 6000A	1050-145	X		
SA-1	Subminiature Adapter for Model 6000A	1050-94	X		X
SA-2	Subminiature Adapter for Tube Testers	1050-99			X
SA-3	Nuvistor Adapter for Tube Testers	1050-127			X
SA-4	Novar Adapter for Tube Testers	1050-144			X
SA-6	Adapter for Testing 829B and 832 Tube Types	1050-107	X	X	X
SA-7	Acorn Adapter for Tube Testers	1050-9	X	X	X
SA-8	Magnoval Adapter for Tube Testers	1050-168	X	X	X
SA-9	Pencil-type Tube Adapter for Tube Testers	1050-121	X	X	X
SA-11	Decal (10 pin) Adapter for Tube Testers	1050-177	X	X	X
SW-4	Socket Saver Set (3 Pcs.) for Tube Tester	1050-60	X	X	X
	MISC. ACCESSORIES				
—	Tube Tester data books (state model number)				
—	Magnetic Shield Kit for Models 511, 512. P/N 100-180				
—	Tilt stand/handle kit for Models 246, 220, 270, 370 (std. on Model 334) P/N 100-181				
—	Tilt stand for Model 511, P/N 19455-7				

Model 615 Sweep and Marker Alignment Generator

- Provides complete T V IF and RF alignment
- Provides harmonic output on UHF

SPECIFICATIONS

Marker Frequency: 2.5 to 5.5 MHz, 19 to 50 MHz, 54 to 108 MHz, and 108 to 216 MHz harmonic.

Marker Amplitude: 0.25 RMS, attenuation to 0.3 microvolt.

Sweep Frequency: 0-50 MHz, 50-100 MHz and 175-225 MHz.

Sweep Width: Variable, 0-15 MHz, linear within 0.1 dB/MHz.

Retrace Blanking: Built-in and controllable from front panel, provides zero-reference base line.

External Sweep Phasing Control: External sweep variable phasing (170°) is controllable from the front panel for use with oscilloscopes that do not have variable sweep phasing control.

Built-in Crystal: 4.5-MHz crystal provides dual markers for IF or RF alignment and signal for inter-carrier sound alignment.

Amplitude Modulation: Marker and crystal oscillators may be amplitude modulated approximately 30% by 900-Hz internal modulator.

Power Requirements: 115-230 volts, 50-60 Hz, 40 watts.

Dimensions: 13-1/4"H x 16-1/4"W x 8"D. 31 pounds.

$495.00

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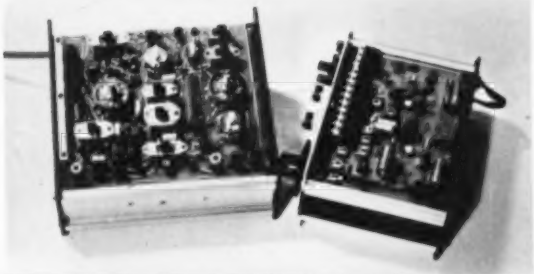

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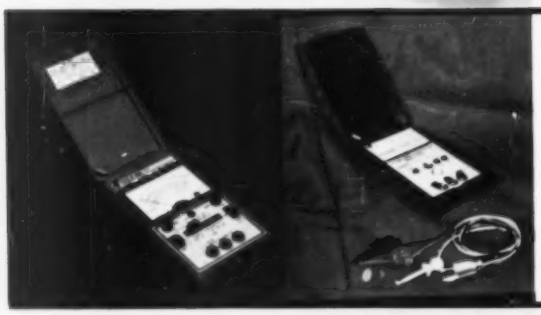

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Cat. No. 75CBA

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Printed in U.S.

An Automatic Dialer for the Deluxe Mobile

by
John W. Crawford WA4SAM
2471 Pyrenees Court
Reston VA 22091

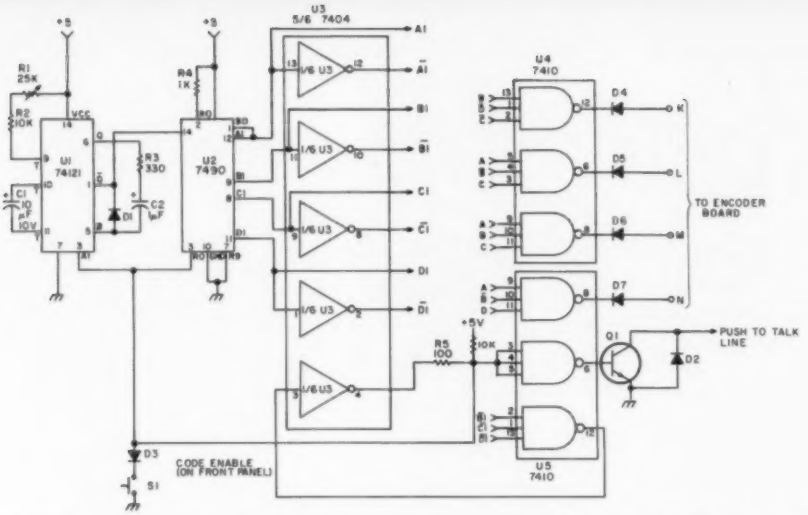


Fig. 1. Code access board schematic. D1-D7: 1N914; Q1: 2N3904 or equivalent. Note: Increase R2 for slower dial rate.

With many autopatch facilities being added to repeaters around the country, it is becoming easier to keep in touch from an automobile with friends, family or various public services. Expensive mobile phone or RCC services are no longer needed for casual conversations. Many amateurs are adding touchtone encoders to their rigs, either in the form of a single box which plugs in to the mike jack on the radio or more elaborate wired-in units which are permanently mounted to the dashboard. Making an autopatch is then easy – one only has to push one or several digits to access the dial tone, then dial a number. However, safeguards on many repeaters dictate that an access code be dialed within a certain time limit, and then the complete seven digit telephone number be dialed within another short time limit. If these times are not followed, the repeater controls will disconnect the circuit to avoid tying up a phone line.

To follow these prescribed limits while moving in heavy traffic is unwise. Many accidents or near misses have occurred when

The unit is a pleasure to use and also functions as a conversation piece, for every time it has been used, someone wants to know how I learned to let my fingers walk so fast through a touchtone pad . . .

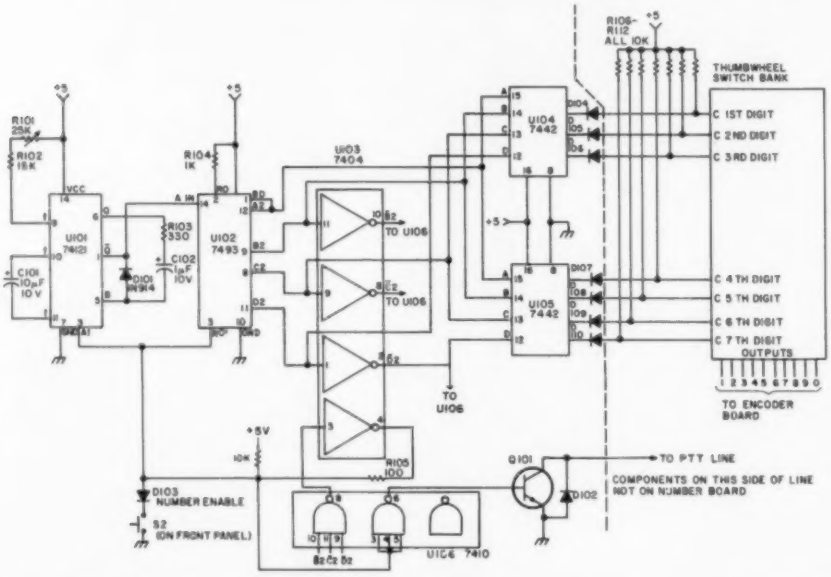


Fig. 2. Number counter board schematic. D101-D110: 1N914; Q101: 2N3904 or equivalent. Note: Increase R102 for slower dial rate.

amateurs have tried to dial while in motion. In this area, a four digit access code must be dialed within 3 seconds and the complete 7 digit telephone number within 7 seconds. With these facts in mind, the pressure to get the sequence correct dictates that full attention be paid to the push-button switches and not to the road. Not wanting to pull over to the side in heavy rush hour traffic or on bumpy under-construction interstate highways in this area, I have invariably dialed a wrong number or had several near misses in the short time my attention was diverted.

I decided there must be an easier and safer way. It was relatively mundane to push one button without looking rather than concentrating on pushing several in proper sequence. After investigating the possibilities of surplus card dialers (there aren't any) and the feasibility of tape recorded touchtones (it's too hard to find the number), I decided to put my dubious education to work.

Obviously, some sort of ripple-through counter was needed for the repeater access code and number to be dialed. Some way of programming any required number was desired, along with an appropriate touchtone encoder to interface with the logic and transmitter. The repeaters in this area (there are five with autopatch) had several requirements, both technical and

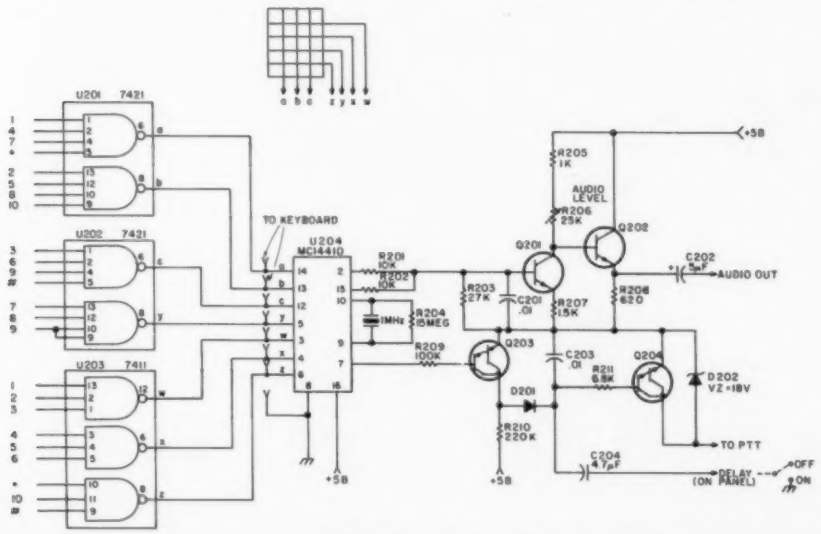


Fig. 3. Encoder board schematic. D201-D202: 1N914; Q201-Q202: 2N3904, MPS-A17, etc.; Q203-Q204: MPS-A14, S9100, etc. (Darlington); C202, C204: 10 volt tantalum; C201, C203: 50 volt disc; R206: ⅛ Watt (CTS X201R253B or equiv.).

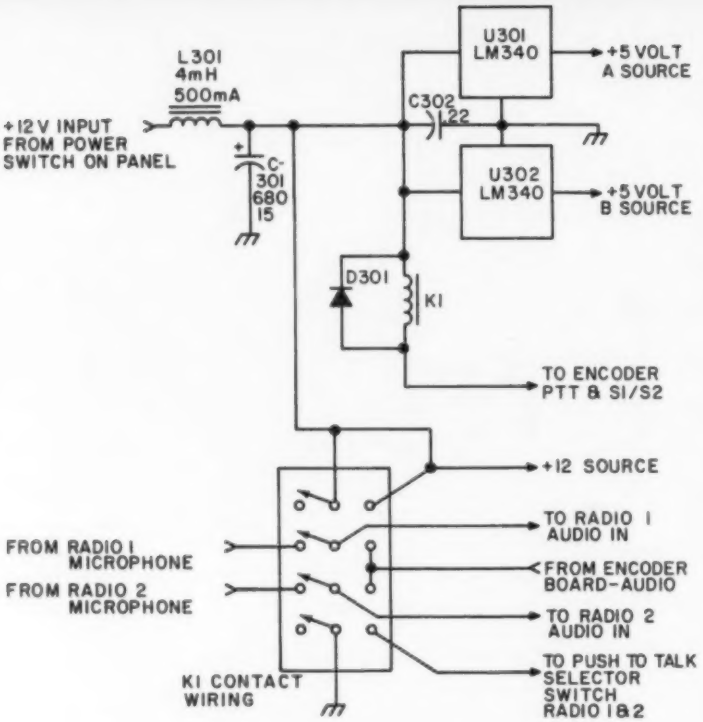


Fig. 4. Power supply and switching arrangement for 2 radios. D301: 1N914; K1: 4PDT 12 V Magnecraft W77CSX-2.

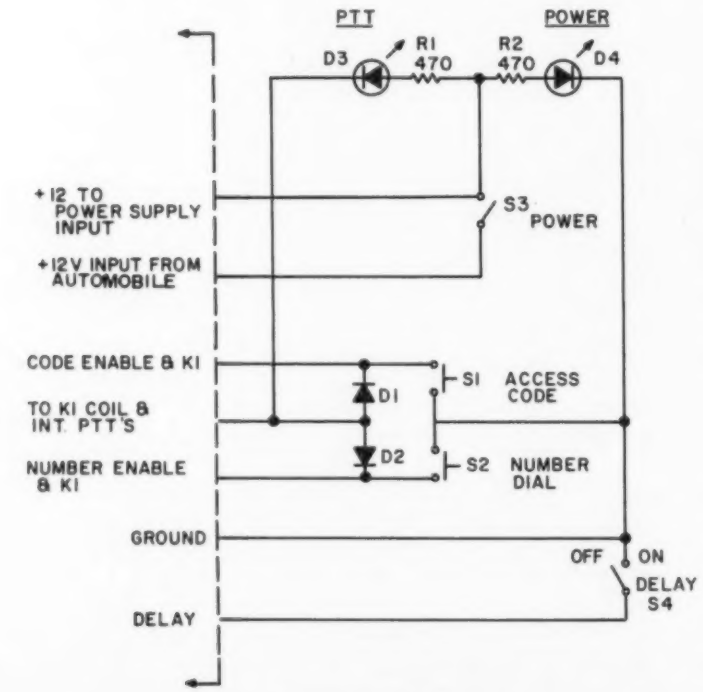
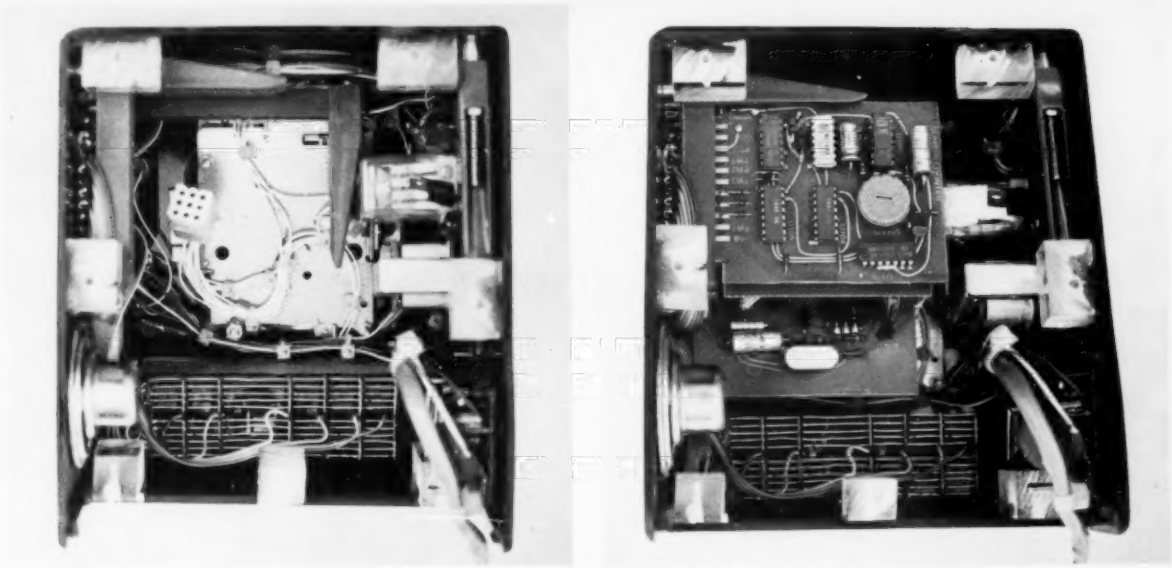


Fig. 5. Panel wiring. D1-D2: 1N914.

administrative: Deviation should be within certain limits (4-5 kHz); no clipping is allowed; the four digit access code must be dialed within 3 seconds, and the complete number within 7 seconds. The administrative procedures dictated that you: (1) Announce your call and intention to make an autopatch; (2) Let the repeater tail drop to reset the agc; (3) Key in the access code and let the transmitter drop for dial tone; and (4) Dial the number. To hang up, any button on the touchtone pad is depressed. Thus, one button to dial the entire 4 digit access code and one button to dial the seven digit number would be needed. Also, a switched ground on the push-to-talk line would be desirable to key the transmitter automatically. For proper impedance matching, the microphone circuits should disconnect and the encoder tones be fed to the audio input on the transmitter, instead of placing both in parallel. Since it would be desirable at times to have a manual entry, a 12 button keyboard should be included. The memory device could be ROMs, PROMs or such, but an easy interface was found to be thumbwheel switches, both for simplicity and to keep the project from getting away from me.

I finally devised the circuits of Figs. 1, 2, 3, 4 and 5. This gives both the capacity of letting the circuit dial the described number or enabling it to be done manually. Operating it is quite simple and takes about 2 to 3 seconds. The procedure is as follows: While stopped at a light or doing one-at-a-time as my attention to driving permits, I set up the telephone number on the thumbwheel switches as I want it. I then key the microphone and announce I am going to make an autopatch. After the repeater tail drops, I push the "access code" button. Immediately, the transmitter keys and the 4 digit access tones are transmitted. The transmitter goes off and I hear a dial tone. Then I push the "Number Dial" button and the same process takes place. The telephone line starts to ring as the transmitter unkeys. After the conversation, I manually depress the hang up number on the keyboard and clear the repeater. So far, the only time-consuming procedures have been the explanations to other hams who call me after the patch to find out how I can dial a number that fast.

The circuit is essentially two counters with separate enable switches. The first is comprised of U1 through U5 and is for the 4 digit access code. If your repeater has just one access digit, this circuit is not needed and you may just as easily use the keyboard. But if 2, 3 or 4 digits are needed for access, the K, L, M and N outputs of the code



Two internal views.

access board may be easily programmed to accomplish this.

The second counter is similar, but counts higher for a 7 digit phone number and runs faster than the access code counter. Seven output pulses are fed to the seven thumbwheel switches, which "choose" an input on the tone encoder board. To the appropriate inputs are also connected the K, L, M and N outputs from the code access board.

To generate the access code, switch S1 is momentarily depressed. This keys the transmitter by grounding pins 3, 4 and 5 of U5, thus driving Q1 into saturation and grounding the internal push-to-talk line. Since the A1 pin of U1 is now low, output pulses appear at pin 1 and are fed to U2, which begins to count to 10. After 2 pulses from U1, pin 12 of U5 goes high and is inverted to a logical zero, holding U2 and U1 on so that S1 can be released. U2 provides a binary count from 0 to 9 and the A, B, C and D outputs are applied to inverters U4 and U5. These gates are wired in such a way as to provide a sequenced output of K, L, M and N with a space in between (see Table 1). After U2 counts to 9, it goes back to 0, which is the reset condition; pin 12 of U5 goes low and its inverter goes high, disabling U1 and holding U2 in the reset condition. As U1 and U2 are reset, the push-to-talk line is unkeyed and K1 returns to its unenergized

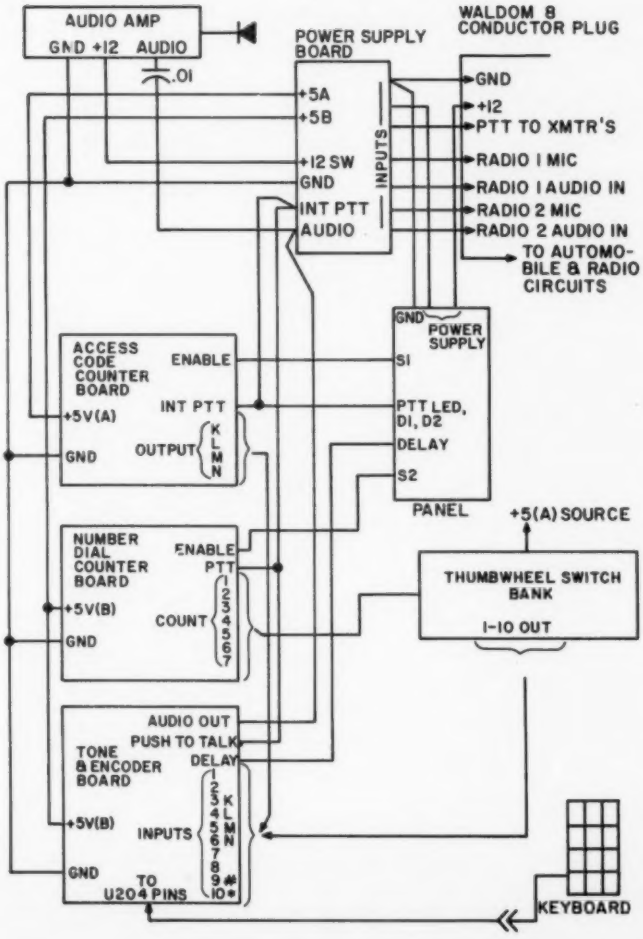


Fig. 6. Circuit board interconnection diagram.

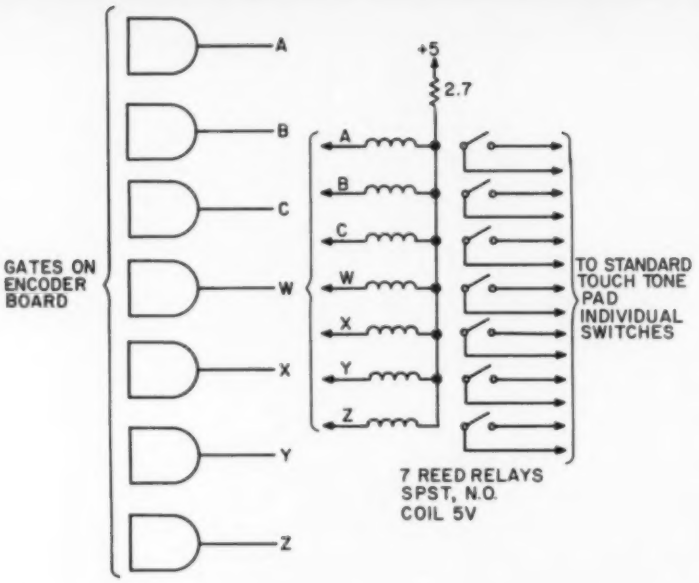


Fig. 7. Alternate method of generating tone. While quite cumbersome, this is a way to interface automatic circuitry to an existing pad. Outputs from reed relays are wired in parallel across existing pad switches.

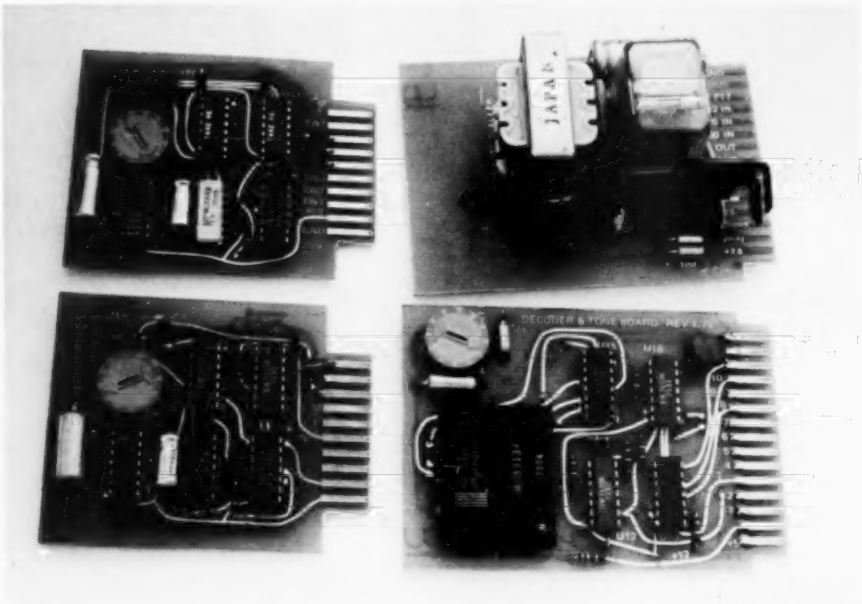
Etched and drilled PC boards as shown in this article are currently available from M-Tech Engineering Inc., Box C, Springfield VA 22151.

position. Because many repeaters require the first digit to be held longer than the others, the K output has been made 2 clock pulses long.

The K, L, M and N outputs are all logical zeros and are hard wired into the appropriate numbers on the encoder board. If no code is required, or if it is just as simple to push a single access tone, the access code counter board may be completely omitted.

The speed of the sequenced K, L, M and N outputs may be adjusted by changing the speed of clock U1, which is easily accomplished by control R1. If some repeaters need a faster pulse than is available, the 10k resistor (R2) in series with this control may be reduced or omitted. Conversely, a higher value of R2 will produce a slower speed.

To generate the telephone number, a separate similar circuit is used. U102 is wired to U104 and U105 in such a way as to count to 16 (see Table 2). The B, C and D outputs are inverted and fed to a section of U106, which provides the same controls as on the code access board, resetting U102 and disabling U101. U104 and U105 provide 7 logical 0 outputs which are wired into the common terminal of each thumbwheel switch. These logical zeros are routed through the switches to the appropriate inputs on the encoder board. As in the code counter circuit, the speed is fully adjustable with control R101.



The four PC boards. Clockwise, from upper left: number counter, power supply, encoder, code access.

Count (U1)	Desired Condition	U2 Outputs D_1	C_1	B_1	A_1	U3 Outputs $\overline{D}_1$	$\overline{C}_1$	$\overline{B}_1$	$\overline{A}_1$	Reset Line R_0' and A_1	U4 and U5 Outputs K	L	M	N
0	RESET	0	0	0	0	1	1	1	1	1	1	1	1	1
1	PTT KEYED	0	0	0	1	1	1	1	0	1	1	1	1	1
2	K	0	0	1	0	1	1	0	1	0	0	1	1	1
3	K	0	0	1	1	1	1	0	0	0	0	1	1	1
4	SPACE	0	1	0	0	1	0	1	1	0	1	1	1	1
5	L	0	1	0	1	1	0	1	0	0	1	0	1	1
6	SPACE	0	1	1	0	1	0	0	1	0	1	1	1	1
7	M	0	1	1	1	1	0	0	0	0	1	1	0	1
8	SPACE	1	0	0	0	0	1	1	1	0	1	1	1	1
9	N	1	0	0	1	0	1	1	0	0	1	1	1	0

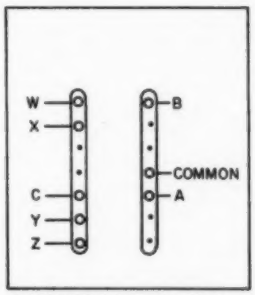
Table 1. Truth table, access code circuit. When S1 makes R_0' and A_1 low, U1 provides pulses to U2. At each pulse, U2 counts from 0 to 9 in binary form. The enable switch S1 is held for 2 counts. When the reset line goes low, S1 may be released. At the 9th count, U2 returns to 0, which is the reset condition. If S1 has been released, R_0' and A_1 go high, resetting U2 to 0 and disabling U1. As the sequence progresses, the K, L, M and N outputs go to logical 0s in turn.

It should be noted that either of the 2 enable switches, when depressed, will cause the transmitter to key and tones to be sent. If either of their respective clocks is running very fast, some means of monitoring the tones should be present. Too fast a clock rate will result in 2 or more sequences or "bursts" of tone to be sent as the enable switch is depressed and then not released fast enough. LED indicators are convenient (more about these later) but a small, pre-assembled $2.95 Radio Shack 100 mW amplifier was used in the prototype, with a small speaker. Muted tones are heard as the unit sequences. This is also handy in checking the overall operation every time it is used. Instead of using a volume control, 2 resistors were chosen to take the place of the suggested pot and wired in place to the foil side of the amplifier.

The tone and encoder circuitry consists of seven AND gates in 3 DIP packages, which drive the appropriate inputs on a fourth chip, U204. Fig. 3 shows the wiring. The K, L, M and N outputs of the access code board are wired (in that order) to the required numbers on the encoder board. Two or more access code boards may be paralleled for up to as many different access codes required. If your system uses 1, 2 or 3 digits for access, any one, two or three of these access code board outputs may be hard wired onto the proper pin of the tone and encoder board connector in parallel with the thumbwheel switch outputs. The transmitter in this case will stay on for the full count of four. Likewise, the 10 outputs from the thumbwheel switches are connected to their respective numbers, 1-10.

When one of the encoder board inputs goes low (i.e., is grounded), the outputs of the gates involved go low also, driving the proper frequency pins of U204. U204 is coupled through two 10k resistors to a buffer amplifier to provide approximately a 0.9 V P-P max output. This output may be varied by an audio level control for deviation adjustment. The circuit as shown has a 600 Ohm impedance. For transmitters with a high impedance mike input, a resistor of between 50k and 220k should be placed in series with the 5 uF output capacitor.

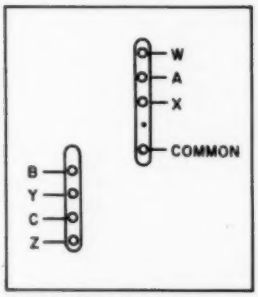
The tones generated are derived from a matrix. Rather than referring to the tone frequencies, the column headings have been designated a, b, c and the rows w, x, y and z (see Table 3). U204 was expressly designed for touchtone format and the circuit board layout is for this particular chip. It is a new



CHROMERICS EFS 21289
(SMALL)
PAD CONNECTIONS

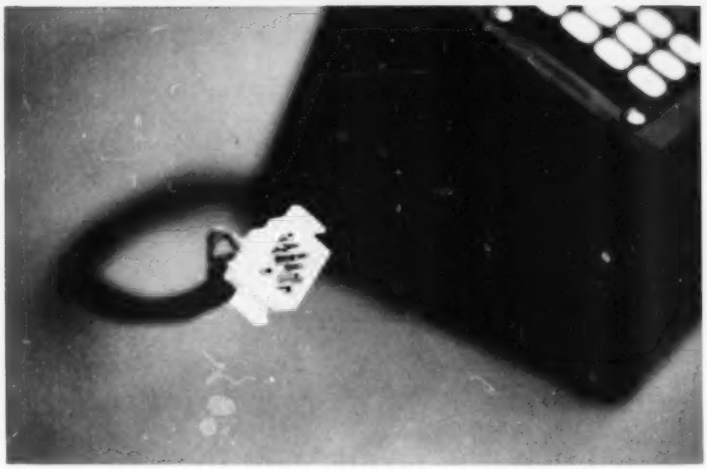
Row or Column Designator	U204 Pin Numbers
a	14
b	13
c	12
w	3
x	4
y	5
z	6
Common	Ground

Number	Designator	Pins U204
1	a w	14, 3
2	b w	13, 3
3	c w	12, 3
4	a x	14, 4
5	b x	13, 4
6	c x	12, 4
7	a y	14, 5
8	b y	13, 5
9	c y	12, 5
*	a z	14, 6
10	b z	13, 6
#	c z	12, 6



CHROMERICS EF20071
(LARGE)
PAD CONNECTIONS

Fig. 8. Chromerics keyboard wiring and interface to U204.



Close-up of Waldom connector plug discussed in text.

device by Motorola and is designated MC14410. A Microsystems International ME8913 touchtone generator IC was tried at first without much success, due to the rf from the transmitter. If you have experience dealing with this and have some on hand, a board layout is available from the author.

The Motorola chip is a CMOS, digitally compatible, free from rf interference, 16 pin DIP, requiring no special board layouts or bypassing. It requires only one extra part for operation – a 1 MHz crystal cut for 13 pF parallel mode.[1] Full 2 out of 7 or 2 out of 8 decoding is provided on-chip from the internal 1.0 MHz oscillator. With the 0.1% crystal specified, output frequency accuracy is ±0.2%, well within Bell System specifications. Voltage requirements are digitally compatible (+5 volts) and, for our application, the chip features a fast turn on and turn off time, as well as stable operation over wide temperature ranges (–40° to +85°C) for mobile use.

Due to the newness of this chip, some difficulty in obtaining one may be experienced. However, Motorola markets worldwide, and the MC14410 will be available from commercial vendors, and later even as surplus, at reasonable rates. The approximate price will be in the $10 to $15 range in single lots. This IC will not need bypassing or ferrite beads around the frequency pins as is required on the Microsystems chip.

The keyboard in the prototype is an EFS-21289 Chromerics[2]. Other Chromerics keyboards may be used if desired, but since the "feel factor" is miserable, a GTE Automatic Electric PK10 or PK11 keyboard, which is identical to the Western Electric pads, will be used on my next model. Any keyboard may be used, as long as it is wired to produce a valid tone. The 2 out of 7 contact arrangements in the keyboards used above are connected directly to the gate outputs or the frequency determining pins of U204. Any other type may easily be used. If one set of contacts closes at a time, for each number, an SPST arrangement is suitable with one side of all the switches grounded and the other side wired to each input.

An old, non-working WE or GTE pad may also be used if the oscillators have sustained damage. The switching arrangement is similar to the Chromerics one, in that two out of seven contacts close at one time. Damaged pads may be easily and inexpensively obtained at hamfests.

The power supply consists of a 4 mH indicator and capacitor to filter out alternator whine and other trash from the vehicle battery line, and two Fairchild 7805, LM340K or other 5 volt regulators capable of handling a total of 220 mA. These two regulated outputs, A and B, are wired to

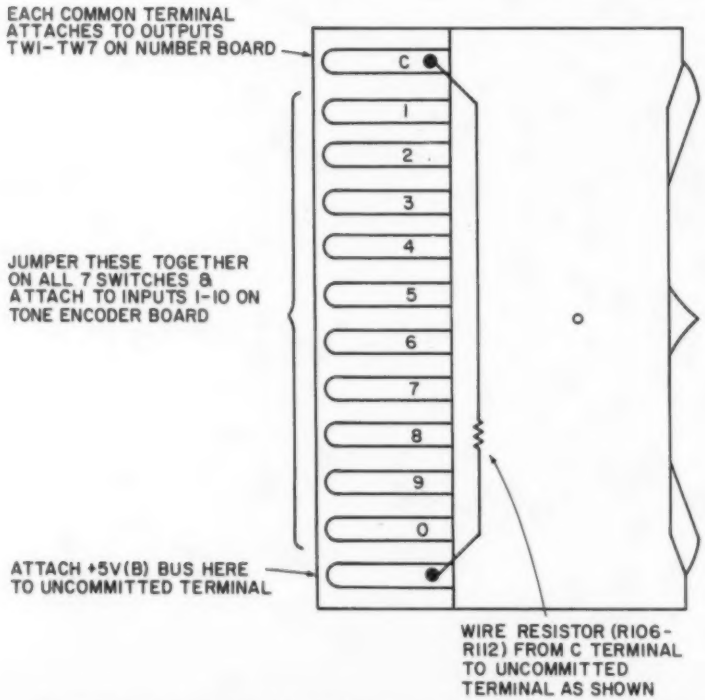


Fig. 9. Thumbwheel switch detail (side view showing method of wiring).

[1] Crystals made especially for this Motorola chip may be obtained from Manann Labs, 425 Main Street, Belton MO 64012 (816-331-5931), for $4.50 each in single quantities, or $2.20 each in lots of 6 and up. Order number ML18P, or ML18W (for wire leads).

[2] Chromerics, Inc., 77 Grand Dragon Court, Woburn MA 01801.

Count	Desired Condition	U102 Outputs D_2	C_2	B_2	A_2	U103 Outputs $\overline{D}_2$	$\overline{C}_2$	$\overline{B}_2$	Reset Line R_0 and A_1	Decimal Outputs of U104 and U105 U104 0	1	2	3	4	5	6	7	U105 8	9	10	11	12	13	14	15
0	RESET	0	0	0	0	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1	PTT KEYED	0	0	0	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1
2	PTT KEYED	0	0	1	0	1	1	0	0	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1
3	1st DIGIT	0	0	1	1	1	1	0	0	1	1	1	0*	1	1	1	1	1	1	1	1	1	1	1	1
4	SPACE	0	1	0	0	1	0	1	0	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1
5	2nd DIGIT	0	1	0	1	1	0	1	0	1	1	1	1	1	0*	1	1	1	1	1	1	1	1	1	1
6	SPACE	0	1	1	0	1	0	0	0	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1
7	3rd DIGIT	0	1	1	1	1	0	0	0	1	1	1	1	1	1	1	0*	1	1	1	1	1	1	1	1
8	SPACE	1	0	0	0	0	1	1	0	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1
9	4th DIGIT	1	0	0	1	0	1	1	0	1	1	1	1	1	1	1	1	1	0*	1	1	1	1	1	1
10	SPACE	1	0	1	0	0	1	0	0	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1
11	5th DIGIT	1	0	1	1	0	1	0	0	1	1	1	1	1	1	1	1	1	1	1	0*	1	1	1	1
12	SPACE	1	1	0	0	0	0	1	0	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1
13	6th DIGIT	1	1	0	1	0	0	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	0*	1	1
14	SPACE	1	1	1	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1
15	7th DIGIT	1	1	1	1	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0*

Table 2. Truth table, number counter board. An asterisk (*) indicates outputs used; others are not wired.

each board as indicated in Fig. 6. Two are used because 1 regulator with a small heat sink ran too hot to touch. The power supply board also contains relay K1, which provides switching for the audio circuits to two radios and a switched ground for the PTT lines.

The manual keying circuit for use with the keyboard is shown in Fig. 3. Each pin of the keyboard is connected, as per Fig. 8, directly to U204. The COR circuit is driven by pin 7 of U204. Negative going (logic 0) pulses occur when any tone is being generated, and are sensed by Q203, which is usually biased on by the normally high output of pin 7. As the logic 0 pulses reach Q203, it turns off and the base of Q204 then rises to the voltage determined by R210, D201 and R211. Q204 then turns on, thereby providing a switched ground for the internal PTT line. When the tone stops, if the delay switch is closed, capacitor C204 discharges through R211 into the base of Q204 to provide an approximate one second delay.

The prototype unit was mounted in a custom made plastic box. The plastic was bent with a strip heater to conform to a space in my automobile. The corners were sanded and buffed to present a smooth molded appearance. Grey smoked plastic was used in the prototype because it was intended to backlight the panel (through Scotchcal plastic photographic material) to indicate the functions. However, space inside the housing precluded the use of bulbs in the required areas, so photosensitive Scotchcal aluminum panel material was used instead. Any suitable enclosure will be sufficient as long as there is adequate front panel space for the brand of thumbwheel switches used and the keyboard.

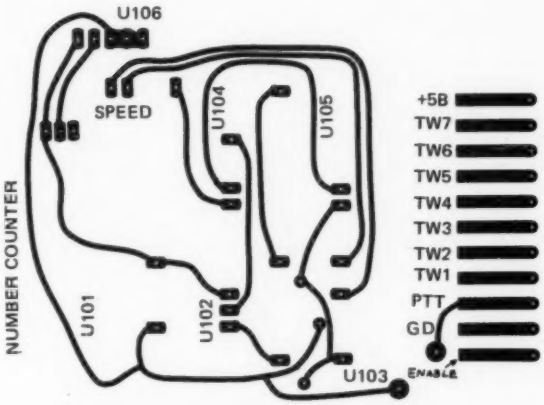


Fig. 10. Top view, number counter PC board (full size).

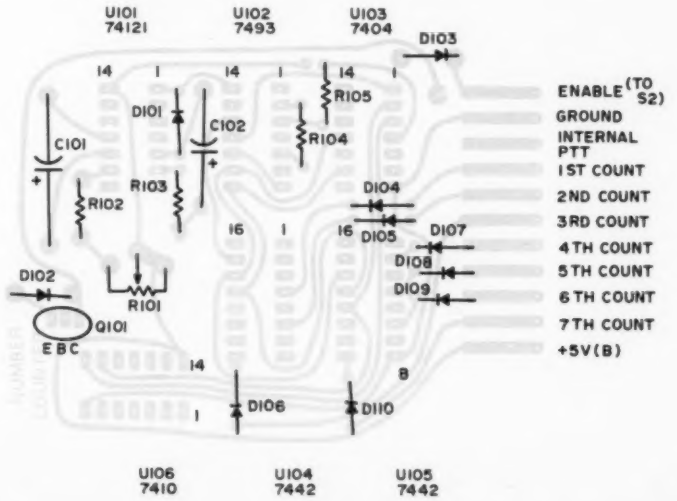


Fig. 11. Bottom view, number counter PC board (full size).

The thumbwheel switch bank consists of 7 thumbwheel switches designed to provide a decimal output rather than BCD. Any 10 position (or 12 position to include the # and *) rotary switches can be used instead, if they are available. Thumbwheels provide a better appearance and the use of a spacer between the 3rd and 4th digits will provide better readability of the full telephone number. The individual numbers 1-10 on each switch are all jumpered together and are wired to inputs 1-10 on the tone and encoder board. Each common terminal of the switches goes to the outputs of the number board: the 1st switch connected to the 1st count, the second to the 2nd count, etc. On most switches, a separate uncommitted terminal is available. These are all connected together and a 10k resistor (R106-R112) attached from this common bus to the common terminal of each switch. The common bus line is then connected to the +5 volt "A" source (see Fig. 9).

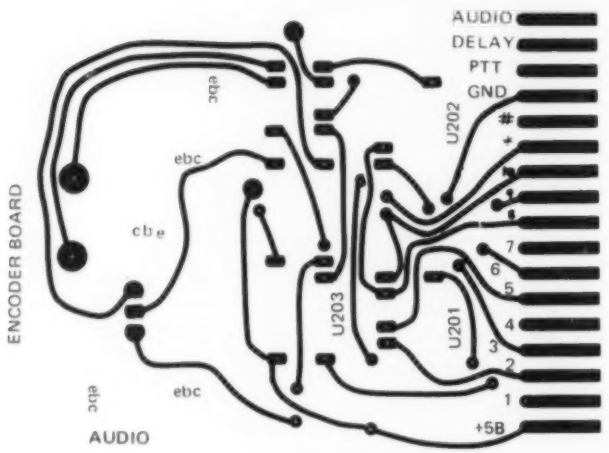


Fig. 12. Top view, encoder PC board (full size).

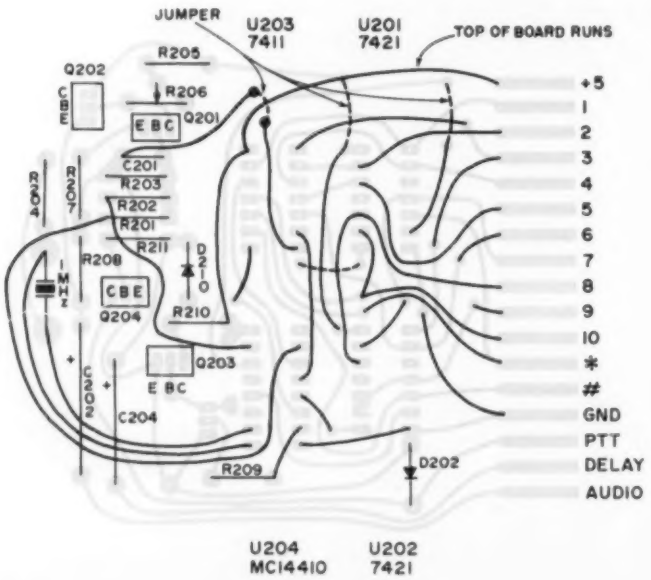


Fig. 13. Bottom view, encoder PC board (full size).

The four boards are plugged into mating board edge connectors mounted inside the cabinet. All wiring is kept as short as possible to maintain neatness, but lead length is not critical. If it is desired, the connectors may be omitted and the boards wired together at the connector foil, making sure that both sides are soldered. A Waldom connector containing 12 pins in a rectangular configuration was used on my enclosure to interface with two radios through a wired-in mating harness. Although the schematics (Figs. 4 and 6) show my hookup, the builder may want to use his own method of microphone and PTT interfacing to his own particular rig. One popular way is to place a microphone connector on the enclosure and plug the mike into it, then make a harness with a suitable plug to attach to the radio mike input. The power supply board containing the audio switching may then be omitted and the 4 mH choke (L301) mounted to the cabinet. The internal push-to-talk line from each board may be used to key the transmitter and the microphone wired in parallel with the encoder audio.

After constructing each board, it would be wise to check the operation before continuing on. The code access and number counter boards are simply hooked to +5 volts and the enable line grounded momentarily. Increased current pulses will be seen on power supplies equipped with milliammeters. The outputs K, L, M and N on the code board and TW1 through TW7 on the number counter board should pulse in sequence on every other clock pulse. A good indicator is an LED tied between each output and +5 volts, with a 220 Ohm resistor in series with each. They should flash in the proper sequence. The speed is adjusted by the pot on each board. Difficulties in performance will be traced to open runs or poor solder joints. Make sure both sides of each board are soldered. The connector pins on each board should be jumpered through the board for added reliability. It was found that the PC board connectors had to be gold plated as the tin plate aged and made poor contact with the edge connector.

The tone and encoder board may be checked by hooking a small audio amplifier to the audio output, +5 volts and ground to the proper terminals, and grounding each input in turn. The tones should be fully adjustable with the level set adjustment. If

difficulty is experienced, short one each of the a, b, c and w, x, y, z pins of U204 to ground to insure that the chip is operating. Then work backward to each gate, placing a ground on the input and checking that the output goes low.

If all seems to be working, wire the printed circuit card connectors together following the overall schematic in Fig. 6. In this case, wire wrap is very helpful if you have the capability. However, use of small # 22 or # 24 wires will aid in ease of wiring. # 20 or # 22 should be used in the external cable for better handling. The edge connectors can be a cinch 50-10-A-20, 2 cinch 50-12-A-20 and a 50-18-A-20 or their equivalents.

Again it is better to check the progress as you go along rather than find you made a wiring error later. Do the power supply connector first, wiring all internal connections and the external cable harness. Then wire the tone and encoder board connector to the power supply. Check operation at this point by applying +12 volts to the external input plug and generating a tone to see if relay K1 closes. Grounding the wire from the "delay" pin on the encoder board will cause the relay to release approximately 1 second after the tone stops. If all seems normal, proceed with the code and number counter boards. Grounding either enable input on these should generate the proper tones. The K, L, M and N outputs should be wired (in that sequence) to the tone board inputs corresponding to your repeater access code. If you only use 2 or 3 tones for access, use the first 2 or 3 letters of the sequence, because the K output stays on twice as long as the others (e.g., two clock pulses).

Next, wire the front panel controls. If the Chromerics pad is used, it should be mounted very carefully, making sure there is an easy fit between the 4 plastic shoulders. Warping this pad in the installation may make one or more contacts close, thereby keying the push-to-talk continuously.

If you elect to use an LED indicator over each thumbwheel switch so the scan sequence can be seen, wire these in next. The prototype had this feature but on later versions they were omitted for being redundant. Operation is heard with the internal audio amplifier, and the push-to-talk line indicator LED shows the sequence just as well. If they are used, attach a 270 Ohm resistor to each LED. The other end of the resistor goes to the 5 volt bus line on the switches and the anode of the LED connects to the common terminal on each switch (see Fig. 9).

Check for shorts in the wiring and then

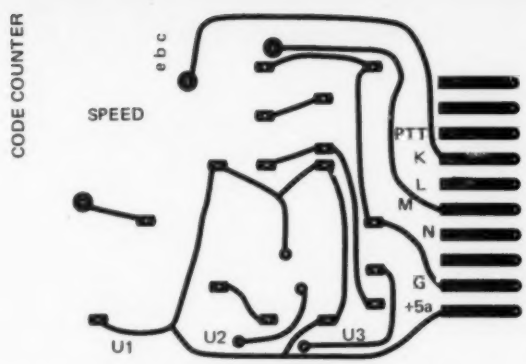


Fig. 14. Top view, code counter PC board (full size).

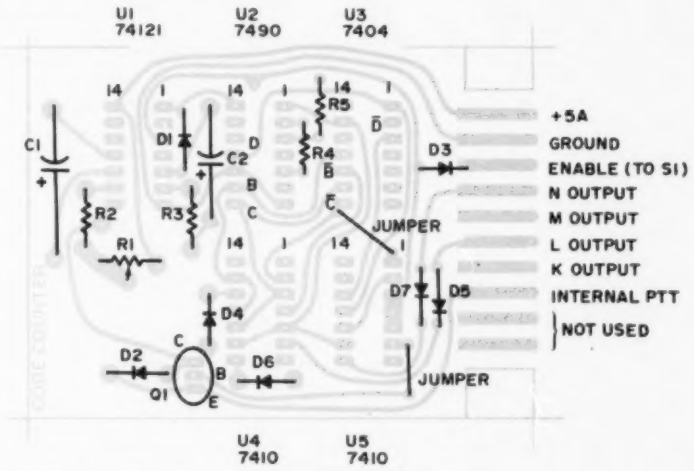


Fig. 15. Bottom view, code counter PC board (full size).

apply 12 volts, and check the overall operation. With the delay switch off, push each number on the keyboard and insure that the PTT LED lights and the relay closes. With the delay switch on, a delay of approximately one second will exist before the relay opens. Push the access code push-button (S1). The PTT LED should light, and if any of the numbers in the code correspond to what is in the thumbwheel switch bank, those LEDs above their respective switches should light. When the PTT light goes out, sequence the Number button. Again, each LED above the thumbwheel switches as well as the PTT LED should light, the former in sequence from left to right and the latter as long as the cycle is going. If all seems well, wire it into the transceiver. Do not close the box yet.

To set it up, have a friend listen to your audio and set the level adjust on the tone and encoder board to what he hears as just slightly lower than your voice. (Individual repeaters have different requirements but this should be a good way to "ballpark" set

		U14		
		Pin 4 1209 Hz (a)	Pin 5 1336 Hz (b)	Pin 6 1477 Hz (c)
U14	Pin 12 697 Hz (w)	1	2	3
	Pin 11 770 Hz (x)	4	5	6
	Pin 10 852 Hz (y)	7	8	9
	Pin 9 941 Hz (z)	*	0	#

Table 3. Touchtone matrix showing coding from U15 to U14.

it.) Punch in the access code, both automatically and manually, to check for wiring errors. The automatic code access board speed should be adjusted to just under what is too fast to bring the dial tone up. Next try to dial a number. Again, use both the keyboard and then the automatic feature to check operation. Too fast a dial rate will not be accepted by the telephone company equipment. Too slow a one may result in false dialing when you have a weak signal into the repeater. Ideally, for an exchange with all electronic switching, a speed of 40 ms on and 40 ms off is as fast as you can dial. Some older non-electronic exchanges won't go that fast. The best way is to experiment, leaving the dial rate adjusted just slightly slower than the fastest speed you can dial.

If you have trouble accessing the dial tone or getting the number to ring, be sure your transmitter is on frequency and your deviation is properly set, as well as mike gain (if provided) in your transceiver. Clipping, distortion, noise and otherwise low quality tones will almost never work.

The unit has been in use for about 13 months and has been tested to extremes of temperature, from the bare circuit boards lying on the floor under a 195° F heater, to start-up in the morning when the ambient temperature has been 15° F. With proper components (i.e., tantalum capacitors in the audio coupling and timing circuits), no thermal problems should be experienced. Re-design of the tone encoder using the Motorola MC14410 resulted in extremely reliable operation. The only problems experienced were with the ME8913 Microsystems International generator, which required extensive bypassing and ferrite beads around the frequency determining pins.

One word of caution to repeater groups is in order. It would be easy to manually dial a number like 1-703, then let the logic transmit seven digits very quickly. Since the phone company will allow the 40 ms dialing rate, other listeners may not realize a long distance call has just been placed. Number counters should be standard equipment on all repeaters.

The unit is a pleasure to use and sounds quite professional, just like the tones one sometimes hears on intercity or long distance dialing. It has also functioned as a conversation piece, for every time it has been used someone invariably has wanted to know how I learned to let my fingers walk so fast through a touchtone pad. ■

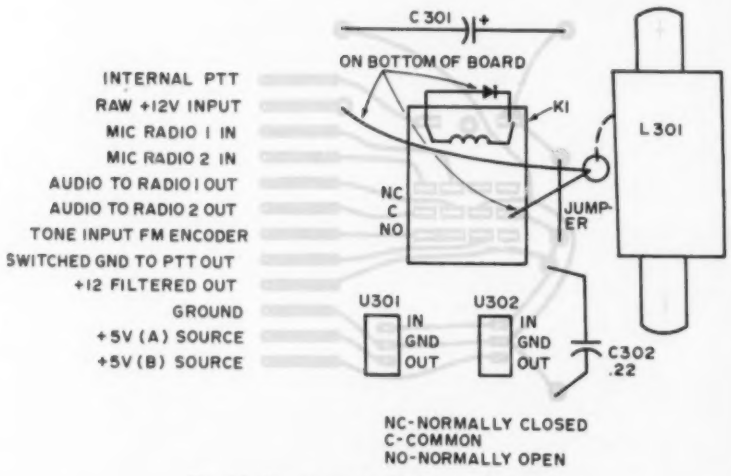


Fig. 16. Power supply PC board (full size).

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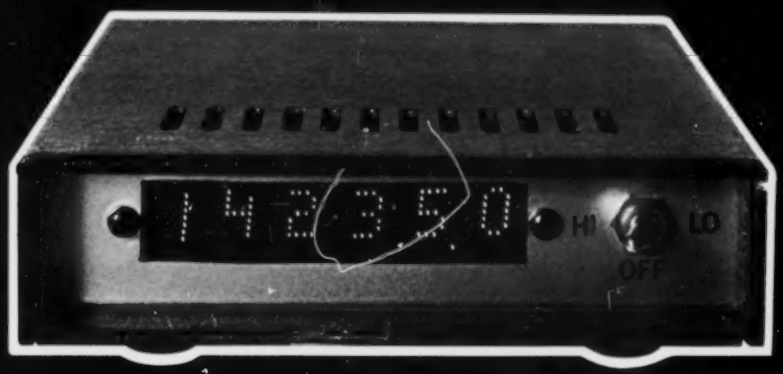

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Zapping Dead Nicads

by
Peter A. Stark K2OAW
196 Forest Drive
Mt. Kisco NY 10549

Though individual nicad cells are relatively inexpensive, complete nicad batteries for specific pieces of equipment often cost an arm and a leg. The 15 volt batteries for 2 meter walkie-talkies are a typical example – they often cost $30 to $60 and up, depending on the source. Anything that can be done to lengthen their life is therefore of great interest.

This article is a continuation of an earlier article I wrote in the December 1974 issue of *73 Magazine*. As a result of that article I have received several letters from readers which have spurred me on to further reading and experimenting. This has led to several techniques for repairing or reconditioning nicad batteries, which should be of help to many nicad users.

A major cause of nicad failure is overheating, caused usually by excessive charge or discharge . . .

In the 1974 article I mentioned that a major cause of nicad failure is overheating, caused usually by excessive charge or discharge. The big problem is overcharging the battery. The resulting heat causes a pressure buildup, which in turn causes venting of the sealed cell through the safety vent. This vent acts like a safety valve to relieve internal pressure and prevent a possible explosion. I had indicated that an occasional slight loss of electrolyte through venting would not cause too much harm, as the safety vent would reseal itself after the venting.

One reader (Lloyd W. Root K7AS) wrote to say that he has had much experience with nicads over many years, and has done a number of experiments on them. One of the things he has found is that some of the nicad safety vents are not resealable. They can be identified by a triangular hole in the positive end of the cell. The small metal tab stamped out of this triangular hole is aimed inward like a sharp point; under this tab is a thin plastic membrane which seals the cell. In case of internal overpressure, the plastic is pushed outward against the sharp point, which punctures a small hole in the plastic to release the pressure. Once this hole is made, it stays there and the cell soon dries up. When this happens, the cell will only hold a charge for a very short time.

Lloyd Root reported having experimented with a number of such dried-out cells. He disassembled one to see how it was put together, and found a place where he could drill a tiny hole through the case without shorting the internal plates. Then he injected distilled water through the hole with a hypodermic needle. By replacing the missing liquid, he renewed the cell to the point where it performed almost as good as new. Though I have not yet tried it, I suspect that a similar result could have been achieved by immersing the cell in distilled water and then applying pressure to the liquid in some way – perhaps by using a thick rubber bag or hot water bottle and squeezing it – to force the water back into the cell. Were it not for the fact that high temperature is very dangerous with nicads, the use of a pressure cooker would be very tempting! In any case, the vent could then be *loosely* covered with tape to prevent the liquid from evaporating again.

It is very important not to cover the safety vent and thus prevent it from working. I am told that when a nicad explodes from excessive pressure it really makes a mess. This brings to mind a dangerous condition I have seen in several batteries. As soldering to nicads is dangerous, welding is used to attach contacts to cells in multi-cell batteries. These connections are generally made with metal strips rather than wire to allow easier welding. In several instances I have seen the metal strip welded directly *over* the safety vent, thereby creating a safety hazard.

I have found that electrolyte leakage can

to Life

How To Make Nicads Behave

cause another safety hazard which may, under some conditions, lead to damage to the battery, charger, or walkie-talkie, and possibly even an explosion. This applies particularly to rapid-charge batteries. Here's why: The electrolyte which leaks out of a nicad is not just pure water, but actually is a conductive chemical. If a cell in a sealed battery such as the 15 volt battery for a 2 meter Motorola walkie-talkie leaks, the electrolyte forms internal leakage paths inside the battery which can discharge cells and form internal high resistance shorts.

Those nicad batteries designed for rapid-charge use have a built-in thermistor connected to an external contact on the battery, which allows the charger to sense internal temperature. As long as the battery is still partially discharged, cell temperature is fairly low and the thermistor resistance is also low. As soon as the battery is fully charged, cell pressure and temperature start to rise. This makes the thermistor resistance go up to 1k and more. This signals the charger to switch from its high-current charge rate (which is designed to charge the nicad in one hour) to the standard low-current charge rate.

Now suppose that electrolyte leakage inside the battery puts a high-resistance short across the *thermistor*. Even though the battery is fully charged and the temperature is rapidly rising, the charger still sees a low resistance and therefore continues charging at the high rate. This can rapidly melt all the plastic parts on both the battery and charger, and in an extreme case even cause an explosion.

Short of periodically opening the battery to look for leakage (and rinsing it out with water if you find any), there is no foolproof way of detecting this problem before it causes damage. But there is a simple test which may sometimes spot the problem before it becomes serious. This is to connect a voltmeter across the thermistor contacts on the outside of the battery. You should not measure *any* voltage. If you do, then there must be some internal leakage path between the thermistor and at least one of the cells, indicating that some electrolyte has been vented.

Another common cause of nicad failure is internal shorting of one or more cells. In a single cell you can identify this problem by the fact that the cell measures exactly 0 volts, and when checked with an ohmmeter measures 0 Ohms. In a multi-cell battery you may note that the open-circuit voltage of the battery is less than the usual voltage even after a full charge. A normal nicad cell measuring 1.25 volts under most conditions will reach 1.4 volts or even slightly more during and right after a charge. Thus the 15 volt battery from a Motorola HT-220, which has twelve cells, will read up to about 17 volts right after it is charged. If the open-circuit voltage after a charge is only 15 volts or even less, that indicates that one or more cells are shorted.

I have in the past thrown away a number of shorted cells, and now wish I had kept them. That's because I have found a way to fix them. I presently have four batteries for my HT-220 which were given to me because their voltage was down to as low as 7 volts. I have now been using them for some time to see whether they will fail again. In one of these batteries, which started out with four shorted cells, one of these cells has shorted again, but I was able to again rejuvenate it and it has been working ever since.

The idea came to mind while I was carefully rereading a part of the GE "Nickel-Cadmium Battery Application

Short of periodically opening the battery to look for leakage, there is no foolproof way of detecting this problem before it causes damage . . .

Another common cause of nicad failure is internal shorting of one or more cells . . .

Engineering Handbook," Publication No. GET-3148 (and its supplement GET-3148S), available from the General Electric Company, Battery Products Section, Box 114, Gainesville FL 32601. At one point they mention that sudden failure due to internal shorting of a cell is more common when a battery is discharged than when it is fully charged. Though they are not sure of the exact reason, they speculate that this may be because internal shorts start out by being very small needle-like projections which short the two plates together. A well-charged cell may be able to burn out this tiny short as soon as it forms by passing a heavy current through it, whereas a discharged cell can't. Well, I thought, once a cell is already shorted why can't we burn out the short by applying an external heavy current burst? I asked several friends for their old, shorted walkie-talkie batteries and went to work.

The first time I did this I took the time to open the battery case using a knife attachment on my soldering iron and a lot of force. Some battery cases are easier to open than others. The cases for the replacement HT-220 batteries made by Alexander Manufacturing appear only to be glued together at the corners, and easily come apart. The original Motorola batteries, on the other hand, are sonically welded all around, and attached with two studs in the middle as well. Quite a bit of huffing and puffing is required to open them up.

Once open, I borrowed a trick suggested by K7AS. He noted that a cell which has been reverse-charged will not take a charge of the proper polarity unless first given a heavy burst of current from a regular dry cell connected directly in parallel with the nicad. Since a new dry cell has a voltage of about 1.5 volts and a fairly low internal resistance, this pushes a good current through the nicad, forcing it to take on the proper polarity. When the nicad cell reaches 1.5 volts, the current drops to a very low value.

Once a cell is already shorted why can't we burn out the short by applying an external heavy current burst?

Knowing which cells of my battery were shorted, I took a no. 6 dry cell and very heavy leads and connected it directly across each shorted nicad cell, plus-to-plus, for about five or ten seconds. This gave each shorted cell enough of a current burst to burn out the short, and even gave it a slight charge. After removing the dry cell, I noted that the nicad cell now had a voltage across it. Since this particular battery had four shorted cells, I repeated this procedure once for each cell. Once the shorts had been removed, I put the battery into the charger and charged at the standard rate for 15 hours. I have now been using the battery for several weeks, and it has been performing well. I am, however, careful not to discharge the battery all the way lest one of the cells short again, although tests on other batteries to determine total battery capacity – down to a total discharge – have only once resulted in a shorted cell which was easily repaired.

But opening Motorola batteries is a chore, so the next three batteries were fixed without being opened. The procedure is similar – putting a heavy current through the battery – but the technique of doing it is slightly different.

My first try worked, but not reliably. It consisted of taking a 30,000 uF computer-type electrolytic capacitor, charging it to 25 volts, and then discharging it into the nicad battery. After several tries this did bring one of the shorted cells up to voltage, but it appeared to be a laborious job at best. Obviously more drastic steps were needed.

I, therefore, started by putting the entire battery into the charger and charging at the standard charge rate (.1C) for 15 hours. Though this did nothing for the shorted cells, it did result in the good cells being fully charged. Now I took a pair of pliers and connected the jaws directly across the battery terminals to provide a nice, low-resistance short across the battery for about 2 to 3 seconds. The resulting short-circuit current, provided by the good cells in the battery, burned out the shorts in the shorted cells. It also slightly reverse-charged the bad cells, which I immediately counteracted by putting the battery into a high-current (.5C) charging circuit for about 30 seconds. Then I charged the batteries for several more hours in the standard .1C charger, and checked the open-circuit voltage. In a few cases, the treatment had to be repeated several times to repair all the shorted cells – one of the batteries had 5 cells out of its 12 originally shorted – but eventually the battery voltage came up to 17 volts after a charge, and stayed there.

In addition to the reference given earlier to the GE nicad manual, other prominent nicad manufacturers include Gould, Eveready and Union Carbide, who may be able to supply additional information if you need it. There is also a booklet available from the U.S. Government, which I have requested but not yet obtained; it is a report entitled "Chargers and Charging Techniques," no. LESP-RPT-0202.00, which applies specifically to nicads used in portable radio gear. It is available from the National Criminal Justice Reference Service, Law Enforcement Assistance Administration, U.S. Department of Justice, Washington DC 20530. ■

Plugboard Extender for Under $3.00

by
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Recently, I had the opportunity to purchase some surplus digital equipment. One such unit, a specialized shift register type used to test some NASA space hardware, contained approximately 50 plug-in circuit boards on which were mounted hundreds of transistors and other components. This unit, once an example of state-of-the-art construction, is now 10 years old and in these days of integrated circuits is in style about as much as a '53 Studebaker. So, I was able to acquire the gear for only $5.

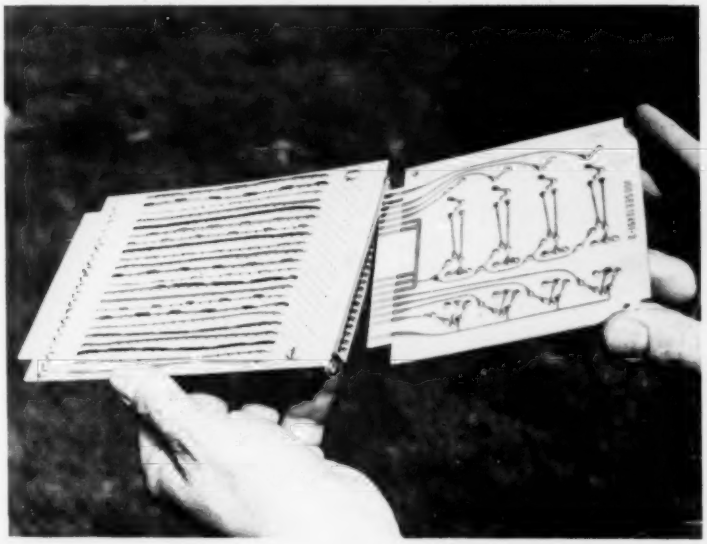
However, before I even thought of cannibalism, I could not resist firing up the equipment to see what would happen. (The unit contained a husky 5 volt power supply – alone worth the price.) Immediately, lights lit and registers shifted. Well now, after second thought, why not experiment a little bit and see if I couldn't build my own not-so-miniaturized calculator?

First problem was how to get 'scope probes on some test points to find clock pulses, etc. The circuit boards themselves are coated with a thick layer of glop called MFP (short for moisture-fungus-proofing) so direct contact with component leads was not possible. The board sockets would be the next logical place for signal access; however, these were recessed deep within the chassis and covered by wire bundles. Clearly, what I needed was a "board extender," that is, a simple point-to-point wired plug and socket arrangement which would enable the selected circuit board to be connected into the chassis circuit while being physically external of the chassis.

A quick glance at my selection of parts catalogs shocked me into the realization that such a simple item was priced at a minimum of $15. This was three times what I had paid for the unit I wanted to test. There had to be a better way – like build my own. Back to the catalogs!

Vector Electronics Co. produces a "Universal Plugbord" series that are blank except for the etched contact fingers and prepunched with a grid of holes for experimental component placement. A 22-contact board of this type is available inexpensively from Burstein-Applebee Co., 3199 Mercier St., Kansas City, Mo. 64111.

Next, an appropriate socket needs to be bolted onto the board, and these are usually available from Poly Paks Inc., P.O. Box 942, South Lynnfield, Mass. 01940. Some scraps of hookup wire connect the two and a handy test aid is added to the shack. ■



Eyes For Your Shack

Conclusion

by
G. E. Friton WØACR
628 Marshall Ave.
Webster Groves MO 63119

The moment of truth (or consequences) has arrived! Install all active components *except* Q303, 4, 5, 7, 8 and 9 in the vertical amp, and Q405, 6, 8 and 9 in the horizontal amp. Set your scope's controls: intensity, three quarters CW; focus, midrange; astigmatism, midrange. The remaining controls will get set as you progress with initial checkout.

Again, remember that those innocent-looking batteries can easily reduce your scope to a pathetic pile of rubble in 2 seconds or so, should a minor disagreement in who is going to control things develop (it will). So use a 1 Amp fuse in series (it'll never blow, of course), to discourage such outbursts of temper.

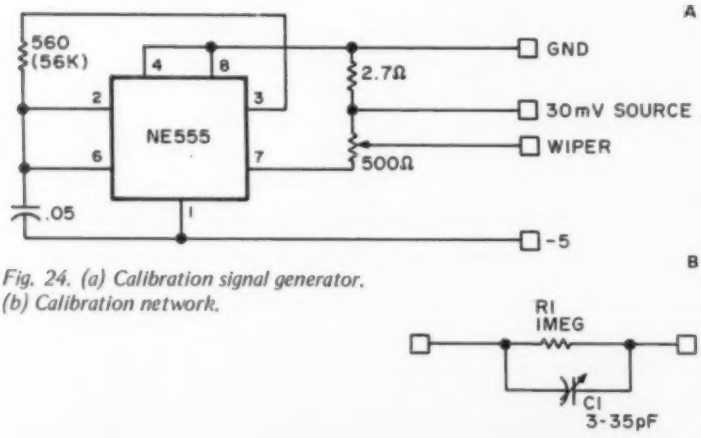


Fig. 24. (a) Calibration signal generator. (b) Calibration network.

Apply power. Note that both inverters start (it won't exactly sound like the Boston Pops, but it'll sure sound good!). Check +5, −5; set +95, positive and negative HV (the latter two depend on the options chosen). By this time, there should be a bright, unfocused spot on the CRT. Set the intensity control for a medium brilliance spot, and check the focus control. Since the astigmatism control has not yet been set, the focus probably won't be too sharp. Reduce spot intensity to dim, and remove power.

Horizontal Board Setup

Install Q405, 6, 8 and 9 in the horizontal board. Set the scope's controls: timebase, 1 ms/div; mode, ac; level, CW; slope, +; horizontal position, midrange; variable controls, Cal.

Apply power. Adjust horizontal position control to give 42 V on the collector of Q405. Then adjust R438 for 42 V on Q408's collector. Beam should now be in the center of the screen. Check operation of horizontal position control — should move the beam from right center to off-screen left.

Set mode to AUTO, timebase to 100 ms/div, and center the trace. Note direction of the sweep; if it's backwards, reverse the connections to the CRT horizontal plates. Set timebase to 1 ms/div. Adjust R422 for a horizontal trace fully across CRT. This completes initial setup of the sweep board. Turn the scope off.

Vertical Board Setup

Next to be adjusted is the vertical deflection amplifier. Insert Q303, 4, 5, 7, 8 and 9 into their respective sockets in the vertical amp. Set scope controls: vertical position, midrange; vertical input, GND; vertical attenuator, 1 V/div; timebase, 5 ms/div; trigger, INT. Turn the scope on. Set R320 on the vertical amp board to give 42 V on Q309's collector. Set R318 for 42 V on Q305's collector. Check that the vertical position control causes the trace to deflect off-screen up and down. Using a flashlight cell, note that trace deflects up for positive vertical input; if not, reverse vertical plate leads. Switch vertical input to ac, and apply your .001% accurate 60 Hz source (finger) to the vertical input. Note wiggly line on CRT. This checks out the basic operation of the vertical amplifier board.

CALIBRATION

Now what is needed is a cheap and simple semi-square wave source, of reasonable risetime. If you have a function generator handy, fine; otherwise, throw together a simple one from a 555. Fig. 24(a) gives the circuit, with 40 ns RT, sufficient for our purposes. The pinouts are correct, backwards as the circuit may seem. Connect test oscillator to −5 V source (scope's −5 is OK). Connect test oscillator's 30 mV output to vertical in. Set vertical attenuator to 10 mV/div, trigger mode ac HF, and timebase to 50 us/div. Adjust trigger level for stable trace; then readjust timebase for 1 to 2 cycles display. Disregarding any overshoot, set R310 (vertical board) to give approximately 3 divisions deflection.

There are two trimmers on the vertical amp board. Initially set each one to minimum capacity position. Then, observing the rising and falling edges of the waveform, adjust each trimmer equally to achieve the best looking edges with minimal overshoot and ringing. Slightly rock each trimmer individually for final tweaking.

Remove the generator, and modify it for 1 kHz, by increasing the 560 Ohm resistor to 56k. Set the generator's pot for minimum output, and reconnect to your scope, using the wiper for vertical input.

Reapply power, and set the scope for dc coupling, ac LF, 5 ms/div. Adjust the level control, if necessary, for a stable presentation of several cycles. Carefully set the astigmatism pot R601, and focus control for best focus in the areas indicated in Fig. 25(b). You will need to alternately adjust each control several times for best focus.

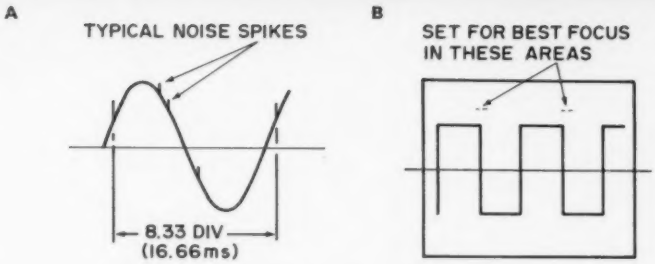


Fig. 25. (a) Timebase calibration. (b) Astigmatism set.

Vertical Attenuator Compensation

Now for vertical attenuator compensation. You'll need the little network, Fig. 24(b). Follow the procedure of the calibration chart carefully. Always set the generator for 3 to 4 divisions display during this procedure.

Following the compensation procedure, you'll need to fine-adjust the vertical gain pot; use a fresh D cell as vertical input, negative grounded. Set the scope for .5 V/div and, with input grounded, set vertical position for a trace on lowest line of graticule. Switch to dc coupling, and adjust R310 for very slightly over 3 divisions deflection. All other ranges are now calibrated.

Only one thing left to calibrate — the timebase. A reasonable job may be done with your calibrated finger, by setting the oscilloscope for 2 ms/div, in AUTO mode.

Vertical Attenuator Calibration Procedure

Vertical Attenuator (V/div)	Generator Output	Adjust	Result (Set for best square wave)
.01	network	C1	Adjusts network to vertical amplifier input capacity.
.02	direct	C714	Adjusts x2 attenuator.
.05	direct	C711	Adjusts x5 attenuator.
.02	network	C713	Adjusts x2 input capacity.
.05	network	C710	Adjusts x5 input capacity.
0.1	direct	C708	Adjusts x10 attenuator.
1.	direct	C705	Adjusts x100 attenuator.
10	direct	C703	Adjusts x1000 attenuator.
0.1	network	C707	Adjusts x10 input capacity.
1	network	C704	Adjusts x100 input capacity.
10	network	C702	Adjusts x1000 input capacity.

Applying your finger to the vertical input will give about 1 cycle of 60 Hz, usually with in-sync pulse-type garbage riding along (fluorescent or dimmer transients). With the horizontal position control, set one of these spikes on the leftmost line of the graticule. Then set R418 to place the next identically-placed spike slightly less than 8½ divisions from the first as shown in Fig. 25(a) – 8.33 divisions to be exact.

To be a bit more exact in timebase calibration, use that handy signal generator in the living room. Simply place the vertical probe near the TV. By locking on field rate, 60 Hz, you have accurate 16.6 ms markers, the vertical sync pulses; and using ac HF coupling, you can lock onto 15,750 Hz (horizontal sync), to check the timebase with 63.5 us markers. To check the highest sweep speed, locate the 3.58 MHz oscillator (if the XYL will let you dig into the set), and drape the probe near it. On 1 us/div, you should have 3½ complete cycles per division. Since part of the timing capacitor is cable capacity, an unknown, wait until everything works, and is neatly cabled, before making any value changes to tweak the 5, 2 and 1 us/div ranges in. Normal cabling length (6" or so) will affect it 10 – 20%.

Congratulations! You now have an indecent oscilloscope! Of course it's indecent – you haven't dressed it up yet!

Professional Touches

Some thoughts on making a really professional front panel . . . remember that template of the front panel? Now's when it'll prove invaluable. Make a few copies of it with carbon paper and use one of these to pencil in the nomenclature in approximate position. Then make a very careful, squared-off version for a lettering guide.

You now have two choices: Either do the finished lettering, actual size, on a piece of lightly frosted mylar, and use by sandwiching it between clear or colored .020 acetate or polycarbonate and white paper, or make a double size version, get an actual size negative, and contact print one on standard black and white photographic paper. Then sandwich this photo between the front panel and acetate. The latter method will generally give a more finished appearance. Note that plexiglas is unsuitable as a cover material, as it will crack under the uneven strain of pulling down mounting nuts, where polycarbonate and acetate simply give a little.

The Charger and Ac Power Supply

Another needed item is an ac power supply – charger for your scope. Fig. 26 is a power supply that will support the scope indefinitely, or fully charge the Gates batteries in about 5 hours, nicads overnight. Use the appropriate network and set the regulator correctly for the type of batteries you have.

Note the use of a non-shortable polarized charging plug, and the diode D601 to prevent backfeed shorts. This diode has proven very handy at times; if you forget the charger, simply use a 150 W lamp (Gates cells) or a 40 W lamp (2A-H nicads) for a charger.

Cleaning It Up

With everything working, it's now time to nitpick a bit. Check to see if inverter garbage is getting into anything; it'll probably show up as small pulses on the trace, or erratic sync problems. Suspect grounding or lead dress problems first. Check by strapping a suspected ground to different points, and moving leads and cables around.

When you're satisfied with your scope's performance, tiewrap the cables neatly. Remember, you may need to touch up the 5, 2 and 1 us/div sweep speeds. Put the cover on, charge the batteries fully and enjoy.

Accessories

First thing you'll want is a good 10x probe, easily carved out of a gutless ballpoint pen. File a small nail into a probe, solder a paralleled 9.1 meg, and 2-20 pF trimmer to the nail head, and add some RG 174 U. Adjust using a square wave.

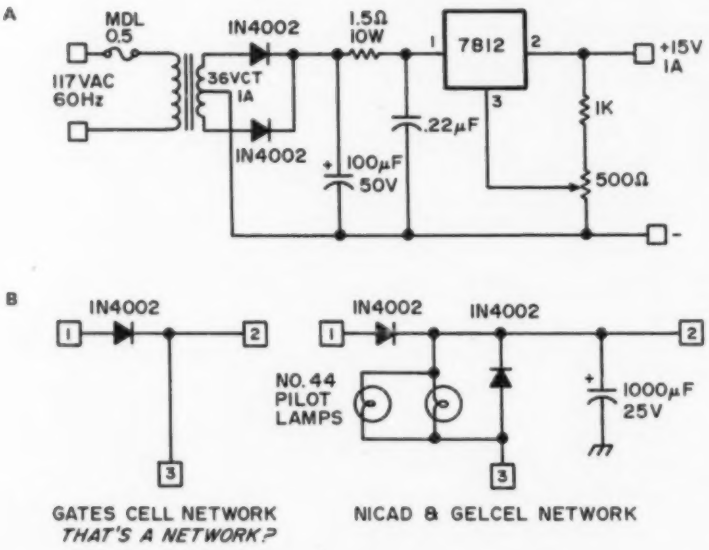


Fig. 26. (a) Power supply – charger. 7812 must be well heat sinked. Set output for 14.7 to 15 V for optimum battery cycle life. 15.6 V will materially shorten life of Gates cells. (b) Charge networks.

Another extra is an illuminated graticule – all that needs to be done is mount a couple of miniature lamps on the plexiglas graticule edge. The scribed lines will glow brightly. A push-for-illumination switch will conserve the batteries.

Also, a handle should be added to your case for carrying ease. A swivel type, mounted somewhat forward of center, will double as a tilt stand.

Hindsight

Typical of such a project, looking back always finds things that can be improved. A few things you might consider for your scope:

1) A x10 expand for the timebase. This is relatively easy to implement: Change R429 to 1.2 meg, and make R422 switch-selectable 10k and 100k pots. Effective top sweep speed will then be 100 us/div. By the way, the 555 gets downright ornery if you try to push it that far, so don't expect it to go much past .5 us/div . . . use the expanded-sweep method instead.

2) A simple but handy addition is switching of the auto mode coupling capacitor (C606) to keep the trace bright at high sweep speeds with no input. Use 1 uF, 0.1 uF, and .01 uF, the latter value to be used with the high sweep speeds.

3) A somewhat better regulation scheme for the HVPS, involving direct tapoff of the negative high voltage, instead of at the first multiplier. This was used in an earlier supply, and is capable of much better regulation, but is more expensive, due to the greater number of zeners required.

4) Dual trace capability: The vertical amplifier is designed to accept this inclusion with minimal changes. Make another vertical preamp, up to Q302 and Q306. Then use an astable multivibrator to drive FET or 4016 CMOS switches placed in series with Q302 and Q306 signal lines, switching between each preamp output. Also include a summing point for all the blanking signals, and trigger pickoff for alternate trace generation.

5) A protective cover, if you intend to use the scope in the field. Such a cover, of vinyl or cloth, can probably be made by the YL or XYL (for the price of a little flattery).

A Wee History

Begun from scattered ideas in May '74, and completed in September, the scope has since been in constant use and has proven to be extremely useful, stable and rugged. It has been used in 5° weather, kicked, rained upon, and worst of all, subjected to travel in my Jeep. It's a hardy little devil! ■

It's been used in 5° weather, kicked, rained upon, and worst of all, subjected to travel in my Jeep. It's a hardy little devil!

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Build This Digital Capacity Meter

by
I. M. Chladek
PO Box 93
Kenmare
1745
Rep. of South Africa

One of the common problems any constructor faces is determining the exact capacity of a capacitor from his junk box or for use in af filters, etc. Small (and cheap) RLC bridges are not accurate enough and – if, for example, you try to measure 100 mixed values of capacitors from a surplus pack – you may well run out of patience. Furthermore, in the age of integrated circuits and frequency counters, everybody is getting lazy. Well, here is an instrument which eliminates all these troubles, presents the value of capacity instantly in digital form, is highly accurate and is fairly simple to construct.

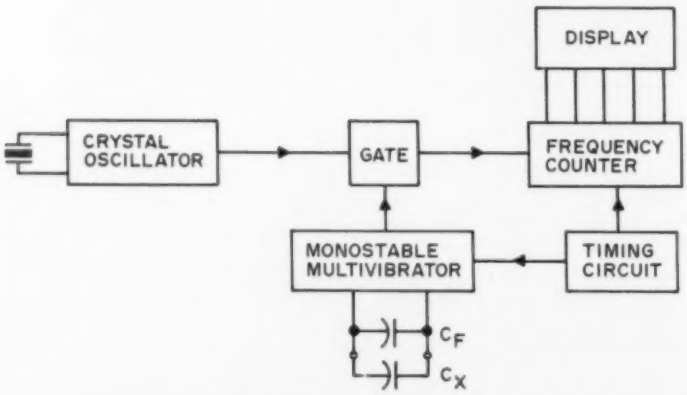


Fig. 1. Block diagram.

First, some information about the C-meter:

1) It measures capacitors from 1 pF to 1 uF in two ranges – 9999 pF and 999.9 nF.

2) Display is four digits in the above ranges, with leading zero suppression and overflow indicator.

3) Accuracy is better than ± 0.1% of full range ± 1 digit for higher values of capacitance in both ranges; for lower values of capacitance it is still very good (i.e., it is possible to determine if the measured capacity is 1 or 2 pF). (The above accuracy is of course in relation to the standard used for calibration of the C-meter and applies only for capacitors with a good Q – see text.)

4) No warm-up period is required. It measures immediately after switching on, with full accuracy.

5) Operation is extremely simple, with only two controls: zero adjustment and range switch.

6) With the exception of a power supply, the whole unit fits on two small printed circuit boards.

7) The price of the complete unit should be around $50, depending on how familiar

you are with cheap sources of TTL integrated circuits. (Maybe most of them are in your junk box.)

The basic principle is very simple and well known; the only difference is *how* it has been used. A similar unit was described some time ago, but it measured only higher values of capacitance, and used different devices.

Fig. 1 shows the block diagram of the C-meter. The heart of the unit is the monostable multi-vibrator (MMV), which produces gating pulses. The length of these pulses is directly proportional to the value of capacitor C_X. I had to consider practical limits of the MMV integrated circuit used (SN74121), the crystal oscillator and the frequency counter described later. Using only C_X and no C_F, with the highest permissible value of the timing resistor, will result in a pulse length of about 25 usec (see data book for SN74121). The crystal oscillator frequency must then be 40 MHz in order to obtain "1000" on the display. But, due to the long leads to the terminals for C_X, hum, etc., the display was not stable – especially for values of C_X under 100 pF. To be on the safe side, I decided to start with a value for C_F of 1000 pF. This cured the problem. But with no C_X on the terminals there was "1000" on the display. Well, instead of resetting to "0000", I reset the counter to "9000"; then with no C_X it counted to "10000", but the first digit was not displayed and the resultant display was "0000". Similarly, for higher range, the counter was reset to "9990". Reset circuits are then a bit more complicated and the overflow indicator must be a two stage counter, but this is not a serious complication.

Capacitance ratio between range 1 and 2 is 1:100. To obtain a correct reading on range 2, the frequency of 40 MHz (for range 1) must be divided by 100, resulting in a frequency of 400 kHz.

The last part of the C-meter is the timing circuit. It generates trigger pulses for the MMV, strobe pulses for latches and reset pulses for counters. The last ones are distributed as described above with the help of a few TTL gates.

Flicking of the least significant digit is not suppressed for two reasons: to simplify construction and to enable recognition of differences between, say, 17.0 and 17.5 pF. In the latter case, the display would have changed from 17 to 18. I used cheap Minitrons for display and this determined the frequency of the timing circuit; it must be low enough to read both values comfortably, e.g., 17 and 18. After a few tests I left it at about 2 Hz. The timing oscillator is then running at 20 Hz and is divided by 10 with the SN7490. Pulse "4" is used for

The basic principle is very simple and well known; the only difference is *how* it has been used . . .

triggering the MMV, "6" is used as strobe pulse for latches, and "8" is used for reset pulses. This system works very well, and leaves about 100 ms between trigger and strobe. With 1 uF and 40k Ohm, the SN74121 generates about 25 ms pulses, so that it is well within the above 100 ms. Any other combination of the outputs from the SN7490 is, of course, possible.

I decided (after some consideration) to divide the instrument into two parts:

1) Crystal oscillator, MMV, timing circuits and gate.

2) Frequency counter and display with overflow indicator.

Both parts can be tested separately before final assembly of the C-meter . . .

This arrangement reduces the size of the printed circuit boards which are mounted in parallel and interconnected by means of a few wires. Both parts can be tested separately before final assembly of the whole C-meter.

Frequency Counter and Display with Overflow Indicator

This unit is mounted on a single-sided printed circuit board 110 by 80 mm. Using a single-sided printed circuit board for such a complex circuit results in a few jumpers being necessary. However, the use of double-sided printed circuit board would not be fully justified – it would be much more difficult and expensive.

This unit is basically a 4-stage frequency counter with overflow indicator, which reacts only to every second pulse from the last decimal counter as explained earlier. Decade counters used are SN7490, with the exception of the first one, which must handle frequencies around 40 MHz. An SN74196 is used here instead, as it can handle frequencies over 50 MHz. Latches SN7475 and BCD-to-seven-segment decoders SN7447A are used to drive 7-segment incandescent displays (Minitrons) of a cheap foreign make, type 3015-F. If any other type of 7-segment display is used, you must check to see if the pin arrangement is the same. If not, the printed circuit board must, of course, be modified accordingly. The overflow indicator uses an SN7473, one surplus plastic switching transistor and an LED (TIL209 or similar).

I used IC sockets for the Minitrons only (MOLEX type); all the other integrated circuits are soldered directly into the printed circuit board. With surplus integrated circuits this is a bit risky – the decision is yours.

There are four resets for the counters, as well as one for the overflow indicator and strobe for the latches. Two wires are for switching the decimal point of the second Minitron for the higher range.

Oscillator, Gate, MMV and Timing Circuits

I tried a few types of harmonic oscillators and the most successful is shown in Fig. 3. It is reasonably stable and the output voltage is high enough to drive a buffer stage, which drives high speed gate IC14A (SN74H00). Crystal X is a harmonic type (3rd or 5th harmonic) and *any* frequency between 35 and 45 MHz is suitable. Coil L1 has 10 turns of 28 SWG enameled wire on a 5 mm diameter with a tuning slug. Capacitor C_O tunes with L1 to the harmonic frequency of the crystal X. The coupling coil is 2 turns of insulated wire (24 SWG) over the "cold" end of L1.

The buffer stage Q3 must safely drive the buffer gate IC14A. The easiest way to check if IC14A is driven enough is to measure the

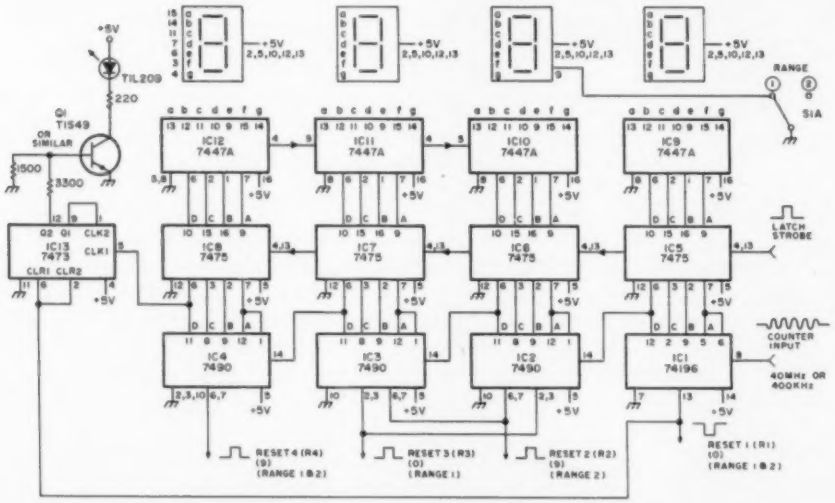


Fig. 2. Note: Cut off pin 4 of ICs 2 and 3 (SN7490).

rf voltage with an rf diode voltmeter at pin 11 of IC14. If the rf voltage is low or unstable, I recommend that you change the value of the base resistor of transistor Q3 or the transistor itself. Unstable or low rf voltages (e.g., under 2 V) will result in unstable or no display of the measured value of capacity. So get it to work one hundred percent. This is probably the only difficult part of the whole instrument.

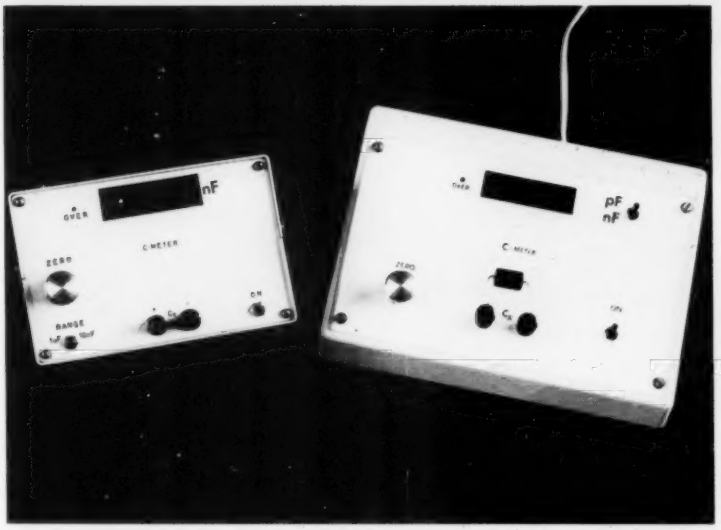
The rf output from IC14A is fed into another gate IC (14B) and divided by 100 (IC15 and IC16). Range switch S1B blocks IC16 for range 1 via IC20E, so that at the output (pin 11) of IC16 there is logical "1". At the output of IC14C (pin 3) is a 40 MHz signal. If the range switch S1B is in position 2, gate IC14B is blocked, the output (pin 8) is logical "1", IC15 and IC16 divide the 40 MHz by 100, and the 400 kHz output (pin 11 of IC16) goes via IC14C to pin 4 of the gate IC14D.

One half of IC17 (dual Schmitt trigger) works as an oscillator; a 47 uF 10 V solid tantalum capacitor and a 470 Ohm resistor make up the timing circuit for approximately 20 Hz. This frequency is fed into IC18 (an SN7490 decade counter). The B, C and D outputs of IC18 are used to produce trigger, strobe and reset pulses. Trigger pulse "4" from pin 8 of IC18 is reshaped in the second half of IC17 and fed into IC21 (the SN74121 MMV), which produces a pulse with length directly proportional to the value of capacitor C_X ($+C_F$). This pulse (at pin 6 of IC21) is used to enable gate IC14D. The output from IC14D (pin 6) goes to the counter input.

Strobe impulse "6" is formed by the B and C outputs from IC18 (the decade counter) in the gate IC19B (SN7400). The output is a negative impulse and, as the SN7475 latches require positive pulses, it is inverted in one of the hex inverters (IC20B) of SN7404.

Reset 1 and 4 pulses are common for both ranges. The D output from IC18 goes via IC19A to Reset 1 (negative pulse). Reset 2 must be a positive pulse – thus, Reset 1 is inverted in IC20A.

For range 1, the Reset 3 pulse must be positive. With S1B in position 1, gate IC19C is open but the output pulse is negative – it is therefore inverted in IC20C. The Reset 2 output is logical "0", as IC19D is blocked.



Two versions of the C-meter.

Get the buffer stage to work one hundred percent – this is probably the only difficult part of the whole instrument . . .

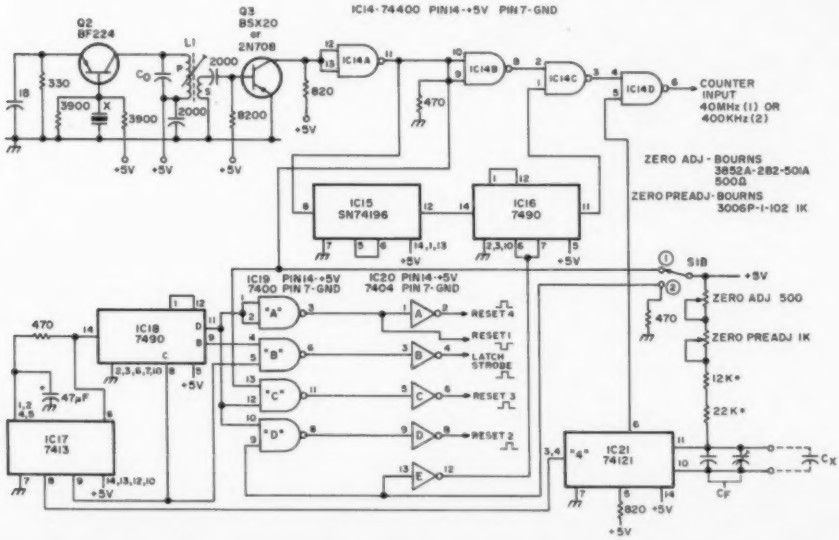
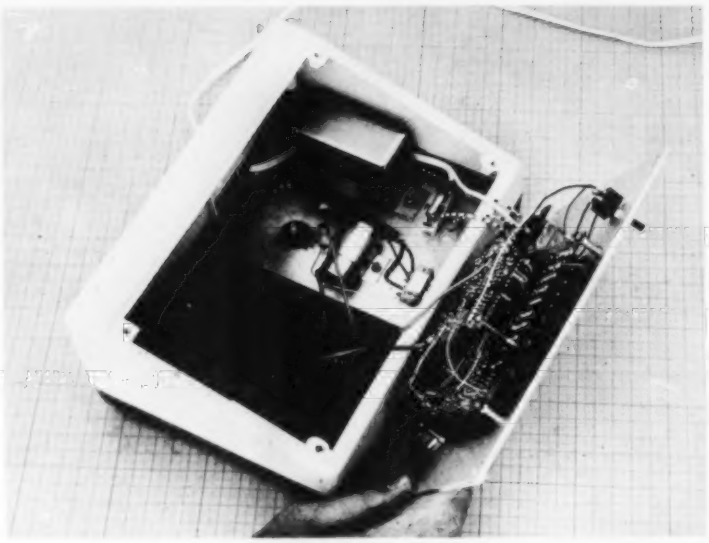
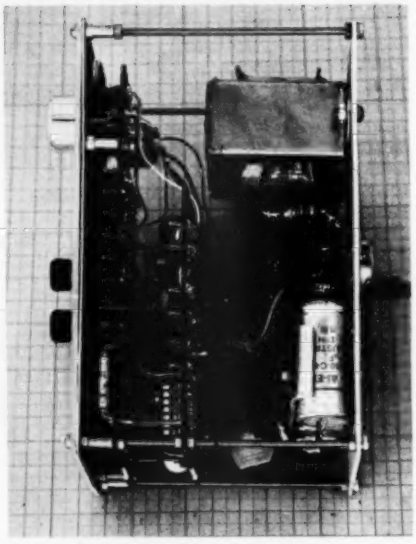


Fig. 3.



Inside view of the C-meter in the plastic box.



Inside view of the C-meter in the metal case.

For range 2, the Reset 2 pulse must be positive. Switch S1B is in position 2 and gate IC19D is open, while IC19C is blocked and the Reset 3 output is logical "0".

Power Supply

The last part of the C-meter is the power supply. It is very simple, thanks to IC22 (MC7805CP). This integrated circuit has built-in overcurrent and thermal protection and is a very good buy for the money. The output voltage should be very close to +5 V (according to the specifications ± 0.2 V, but I have not found any worse than ± 0.1 V). It is rated for 750 mA minimum (short circuit current limit) and this value just suits our requirement (about 700 mA with display "8888"). The typical input-output voltage differential of the MC7805CP is 2 V, but to be on the safe side I used 8 V ac. With a large smoothing capacitor the input voltage is over 9 V dc. Do not try to go under this value (at nominal mains voltage); otherwise, when the mains voltage drops, you are in trouble.

A small capacitor across the output improves transient response. The connection between the 5000 uF and the input of IC22 should be as short as possible. Use heavy wires – they eliminate voltage drops and improve stability.

To suppress spikes from TTL integrated circuits, it is essential to connect a few capacitors of 0.1 uF and 50 or 100 uF tantalum at intervals on both printed circuit boards. The 0.1 uF capacitors are Siemens, type B32540-A3104-J metalized polyester. Their advantage is very low inductance, but even the ceramic disc capacitors will do the job. Be careful about the polarity of tantalum electrolytics; I was not – fortunately the MC7805CP has good protection.

By the way – the IC22 regulator needs a heat sink to dissipate about 3 W. A small piece (100 x 100 mm) of 2 mm (approximately 14 gauge) aluminum is more than adequate; if a metal box is used, just mount the regulator on the rear side of the box.

Construction

Mechanical construction is probably the weakest point of most of the amateur equipment. Not everybody has a well-equipped mechanical workshop. I built two C-meters, each one of different construction. I hope that will give you enough inspiration.

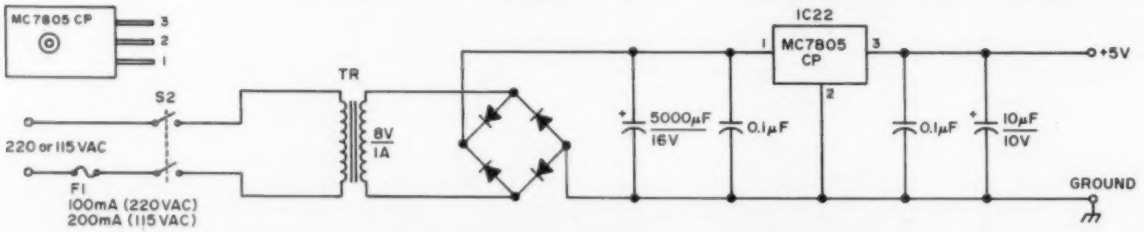
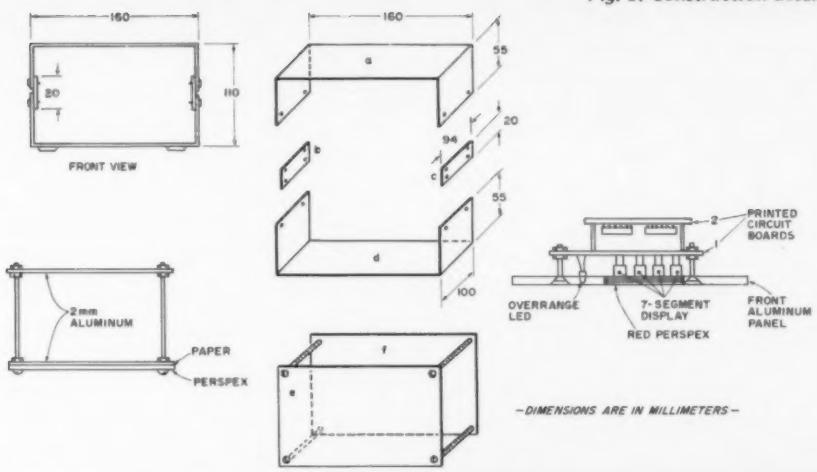


Fig. 4. Note: MC7805CP mounted on a heat sink.

Fig. 5. Construction details.



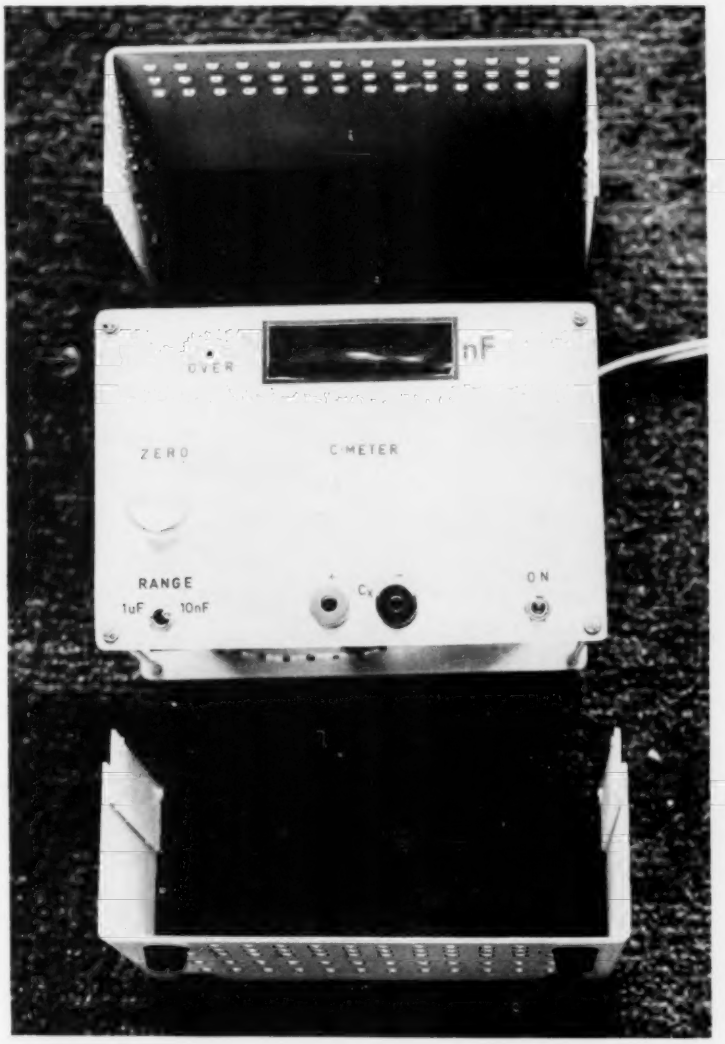
The first prototype was built into a homemade cabinet; the basic dimensions and the general idea are shown in Fig. 5 and the photographs.

U-shaped parts *a* and *d* can be bent in a big vise. The other parts are very simple. Aluminum (2 mm, 14 gauge) can be used for all parts of the cabinet. Start with parts *a*, *b*, *c* and *d*, and then measure the inside dimensions and cut front and back panels *e* and *f* accordingly. (In my case I used steel, and parts *b* and *c* are spot-welded to part *d*.)

The front and back panels are held 94 mm (inside dimension) apart by means of four 4 BA screws 102 mm long. This sub-assembly is then inserted between the two U-shaped parts *a* and *d*. Parts *b* and *c* prevent the front and back panels from moving, and hold parts *a* and *d* together.

After drilling all necessary holes into the front and back panels, clean the front panel and mark all holes with a pencil on a piece of thick white paper which does not change its dimensions with moisture. A white plastic sheet would be even more suitable. Cut off all the marked holes with a sharp knife. Use transfer letters (Letraset or similar) for descriptions of the functions on the panel. Then cut a 1.5 mm thick piece of clear Perspex (Plexiglas) and drill all holes with the exception of the ones for display LEDs and overrange LED. Cut a piece of red Perspex (3 mm thick) which will fit exactly into the hole for the LED display in the front metal panel *e*.

Perspex is supplied with paper sheets glued on both sides. Do not remove these; mark all the holes and outside lines with a pencil and then make cuts with a sharp edge along the outside lines, about 0.2 mm deep. I used the sharp edge of a small chisel (along a steel ruler) with success. Do only one cut at a time. Break both ends of the cut slightly



Mechanical construction of the homemade metal case.

with your fingers. Lay the Perspex over the edge of the bench and break carefully. I recommend that you try this procedure a few times on Perspex off-cuts. The operation is not difficult but does require a bit of practice.

Drilling of holes in Perspex is also a little difficult. The best method is to use a drill press with a maximum of 500 rpm. A bit of practice on a piece of off-cut is not a waste of time. Only after drilling all holes, cutting the right dimensions and smoothing the edge with sandpaper should you remove both paper covers and wash the Perspex with soap and water. A front panel made this way looks professional and is really worth the effort.

The future accuracy of the instrument depends on the accuracy of this 5000-10,000 pF capacitor, so have a good look around for it . . .

The printed circuit board with LEDs is fitted parallel to the front panel by means of four screws with countersink heads, so that they are covered with the paper and not visible.

Both terminals for Cx must be made from a good insulator or fitted on a piece of Teflon (PTFE). Perspex tends to absorb moisture from air – a bad insulator will cause erratic readings.

The transformer, IC22 and the 5000 uF electrolytic capacitor are fitted onto the rear panel. Use a small transformer (or increase the depth of the box), so that it does not interfere with the printed circuit boards.

For my second construction of the instrument I used a ready-to-use plastic cabinet with a metal front panel. This is the lazy man's construction and it is, of course, less mechanically difficult. Due to the bigger size of the box, it does not need the cooling holes that proved to be necessary in the previous construction. The construction of the front panel is the same as in the previous case and I hope that the photos are self-explanatory.

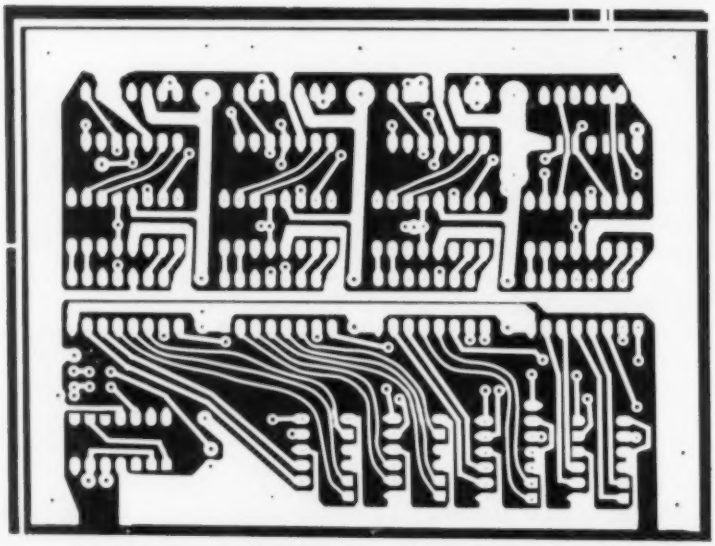


Fig. 6. Counter and display PC board (full size). Copper in white.

Fibreglass printed circuit boards should be well washed with soap and water after etching, rinsed, dried and polished with steel wool. Then spray both boards with soldering varnish and let them dry in the oven. I am sure that your wife will be very pleased with the pleasant smell of the varnish in the kitchen. Anyway, this protection is very important; otherwise, after a few years you might be surprised to find that your C-meter does not work. Only after this procedure can you start drilling the holes into the printed circuit boards. Holes 0.8 mm in diameter are adequate for all components and wires, except the five thick interconnecting wires for the ground and +5 V.

Soldering should be done with a small soldering iron – preferably temperature controlled. Start with the jumpers; a few long ones should be insulated wire, while the others can be bare wire 0.6 to 0.8 mm in diameter. Then solder the components and integrated circuits. Be sure that all integrated circuits are positioned the right way. Do not forget to cut off pin 4 of ICs 2 and 3 (SN7490), before soldering them onto the printed circuit board.

You can test each printed circuit board separately. Use your laboratory 5 V power supply or the one for the C-meter. The current consumption of the frequency counter part with display is approximately 500 mA; of the second part, around 200 mA.

To test the counter subunit, Resets 2, 3 and 4 must be grounded, and Reset 1 must be connected to +5 V. Then connect a square wave generator to the counter input. A circuit of the timing oscillator IC17 (SN7413) can be used (use pin 6 as output). The display will start counting at a random number and will continue to over 9999 and 0000 again.

The second part of the C-meter can be checked with a frequency counter (output from IC14D pin 6). You must, of course, simulate the function of the range switch S1B. Output frequencies (at pin 3 of IC14C) must be exactly at the ratio of 1:100. The latch and reset pulses can be checked with an oscilloscope or, preferably, with a logic probe. The sequence and dependency of the output pulses on the position of S1B was described above.

Alignment

If both parts of the instrument work satisfactorily, solder the two printed circuit boards together. Five thick wires should be soldered onto the counter board; to make

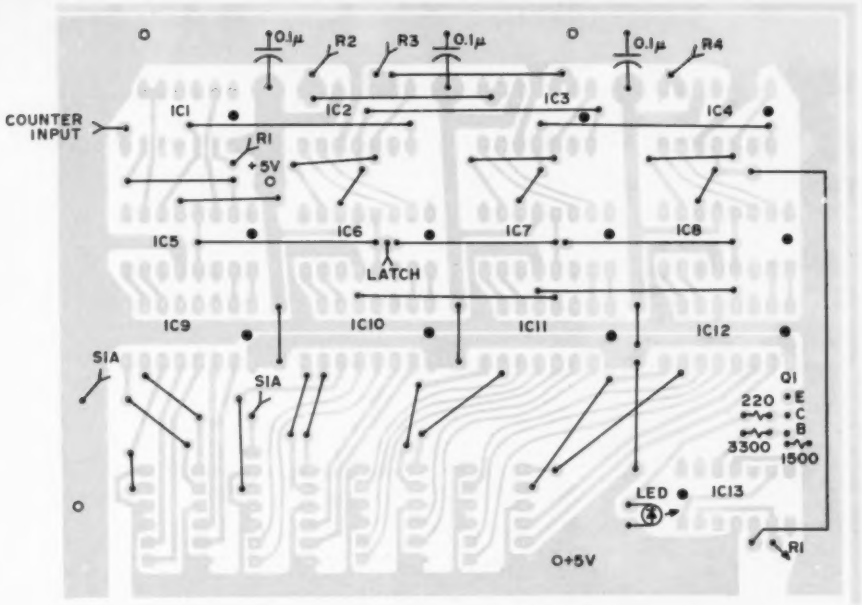


Fig. 7. Component layout, counter and display PC board.

this operation easier, use differently colored insulation on the interconnecting wires. The same applies to the range switch wiring.

Check the output voltage of the power supply. If possible, load it with a 6.8 Ohm resistor to check if the output voltage is stable. This checking is important, as any voltage over 5.25 V can damage some integrated circuits. Then check the current consumption of the whole unit. It should be under 0.75 A. If everything is OK, you can start with alignment.

Set "Zero Adj" (ZA) and "Zero Preadj" (ZP) to the center positions. Solder a few (2 or 3) capacitors, which are stable with temperature, across the C_X terminals (inside the cabinet). I used plastic molded silver mica and polystyrene without serious problems. In parallel, solder a small mica trimming capacitor (20 to 50 pF). The total value of all of them should be about 980 pF. They form capacitor C_F.

The difficult problem here is to get hold of a very accurate capacitor whose value is between 5000 and 10,000 pF. The future accuracy of the instrument depends upon the accuracy of this capacitor. So have a good look around for it. Note that either input terminal is grounded. Of course, the one marked "+" is not very sensitive to hum, etc.

With no capacitor C_X you should be able to adjust the instrument to show zero on the display, with the values of resistors 12k* and 22k* next to ZA and ZP. But if you used a crystal of a frequency lower than 40 MHz, these resistors will be slightly higher in value (say 33 and 10k) and vice versa. By the way – they must again (like ZA, ZP and C_F) have a very low temperature coefficient. It is best to start with ordinary resistors and replace them, after finding the right values, with high stability ones.

Anyway, adjust zero with ZP, and then connect the precise capacitor C_X. If it reads low, adjust capacitor C_F to the lower value.

Take advantage of this instrument – it measures with practically full accuracy within a second of being switched on ...

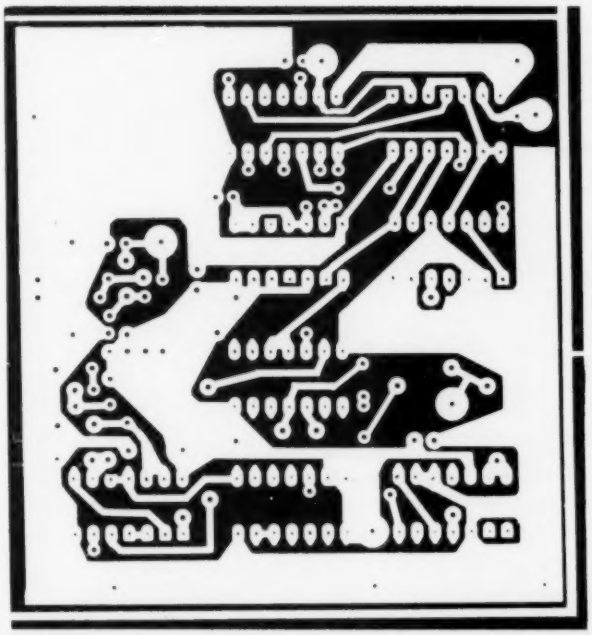


Fig. 8. Oscillator, gate and timing circuits PC board (full size). Copper in white.

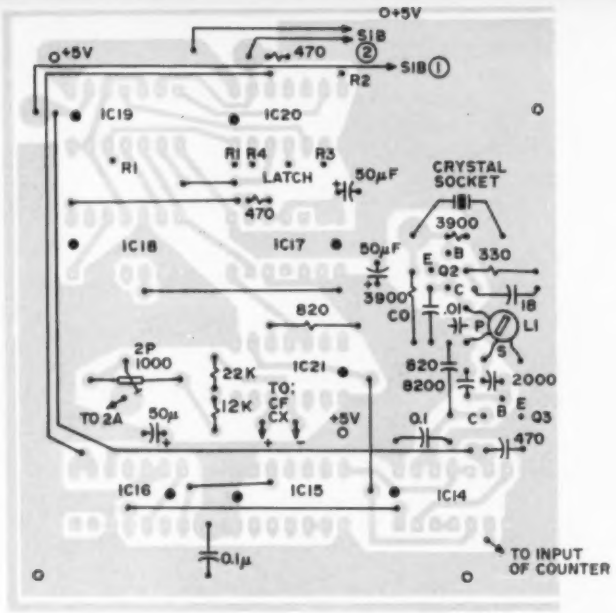


Fig. 9. Component layout, oscillator, gate and timing circuits PC board.

Remove C_X and adjust zero with ZP (changing 12k* and 22k* if necessary). Try it again with C_X and adjust C_F. Remove C_X and adjust the zero with ZP. (Basically, when the display shows a low value, you must lower the value of C_F – and vice versa.) Continue in this way until the display shows zero without C_X and the right value with C_X. During this procedure ZA is adjusted to the middle position. And that's it. Now you can take, say, twenty mica or polystyrene capacitors 200 to 500 pF, measure each one of them, mark the value and add them one after another in parallel on the terminals of C_X. The difference in total readings should at any point be not more than ± 2 digits. If more, then the insulation between terminals 10 and 11 of IC21 (MMV) or between terminals C_X is bad and must be improved.

This procedure, of adding measured capacitors in parallel, demonstrated the excellent linearity of the SN74121 MMV. Originally, when I started the construction of this instrument, I did not expect such good results. It is really amazing how these small plastic 14- and 16-legged spiders perform.

The higher range 2 does not need any alignment, as it is automatically OK when the lower range 1 is adjusted.

Conclusion

Inside the cabinet, the integrated circuits, display, IC22, etc., dissipate over 5 W. Certain crystals tend to be unstable at the high temperature which can develop when the instrument is switched on for a long period of time. In this case, I recommend that you drill a lot of small holes in the top and bottom of the cabinet in order to allow air to circulate along the printed circuit boards.

Take advantage of this instrument – it measures with practically full accuracy within a second of being switched on. Just adjust the zero by means of ZA (with range switch in position "pF," even when measuring in the nF range) and connect the capacitor across the terminals C_X. If you measure a lot of capacitors, check the zero from time to time, as it drifts slightly with temperature.

The overrange flickers when you exceed the range. This is much better than a steady signal.

If you are measuring solid tantalum capacitors, connect them with the correct polarity at terminals C_X. The polarizing voltage across these terminals is about 3 V dc. This low voltage limits accurate measurement to only low voltage electrolytic capacitors.

If the reading is not stable and changes by more than ± 1 digit, then there is something wrong with the capacitor and you would do best to throw it away. ■

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If you have ever operated RTTY for extended periods, I expect you have tired of repeated typing of your call in RTTY, then had to send your call in CW. You also included a time and date print on those special RTTY contacts that could help you toward WAS or DXCC. Were you slowed down in that contest when time was a required part of the text? Here is a small, easy to build circuit that will give you the ability to print the time and date, and sign your call all at the touch of a button.

During 1972 I became very interested in RTTY operations. Shortly thereafter my interests expanded to autostart operations. I was particularly interested in the automated devices that were operational at some of the stations such as WRU Answer Back (Who Are You – a short message sent when a station is called up with a pre-set access code) and Relay Systems. There were a few systems operational that printed the time and date of each WRU or Relay request.

As a result of seeing what was available I started designing a station control unit. First came an electronic "stunt box." Then a WRU using a Model 15 TD and finally a relay system with a well used FXDR. That time/date readout still held my interest – to be able to know when my station had responded to someone's request was a desired goal. Also a time/date printout would provide automatic logging of both received and transmitted messages.

The DDTMG (Digital Date/Time Message Generator) would provide the following functions:

–A programmable message generator using ROMs
–A time readout
–A date readout, with automatic updating – not manual
–A CW generator to meet legal requirements for CW identification

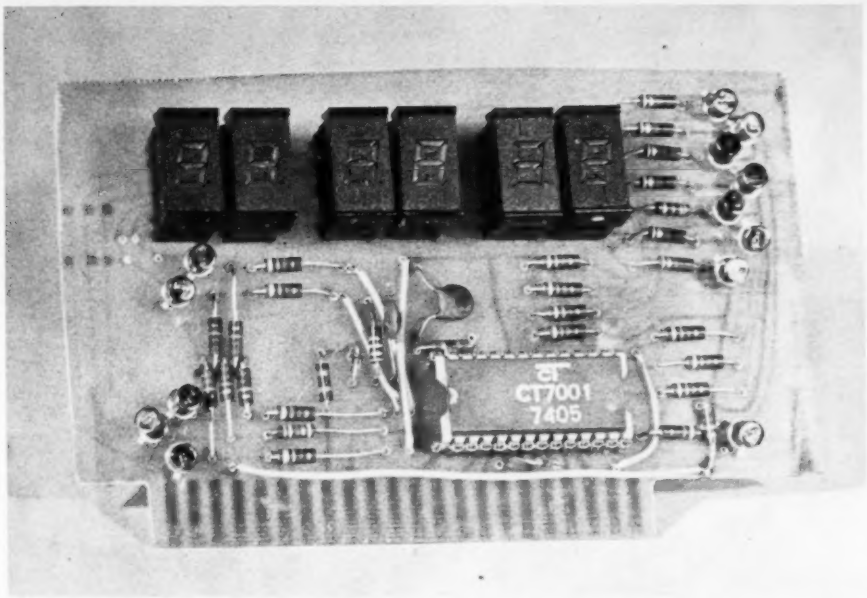
The circuit design would have to use available TTL circuits and would have expandable capabilities for tieing into a complete system approach, using a stunt box electronic equivalent for control.

The circuit consists of the following four basic elements: an electronic clock/calendar, a parallel to serial converter, a memory bank made up of read only memories (ROMs), and a translator/de-multiplexer to convert the output of the clock to Baudot code.

The digital clock is a straightforward application of one of the medium scale

ADDRESS	00000	00001	00010	00011	00100	00101	00110	00111	01000	01001	01010	01011	01100
BIT	01234567	01234567	01234567	01234567	01234567	01234567	01234567	01234567	01234567	01234567	01234567	01234567	01234567
CODING	0000	111 1 1	1	1 111 111	1 111 111	111 111	1 1 1 1	1 111	111 1 1 1		1111		
CW	BLANK	– • •	•	• – –	• – –	– – –	• • • •	• –	– • • •	BLANK	RESET		

Fig. 1. CW message memory for "DE W1HAB." Sending "DE W1HAB" with a blank address before and after the CW message requires 13 positions of the 32 position chip. The first bit could have been loaded starting at any address within the 8223.



The circuit board used for the digital clock. This portion of the project alone is a useful accessory to the shack. The seven transistors in the upper right corner are current amplifiers for the segment lines, the five transistors on the left and one in the lowering right hand corner are the digit select drivers. Molex pins were used to make up the socket for the CT7001.

integration chips currently on the market. The chip develops all the necessary information to indicate both time and date. The 7001 chip also has a built-in backup oscillator that will allow the chip to maintain the proper time even if ac power is interrupted. A battery supply is needed to obtain the necessary operating voltages, however. In normal operation this chip displays time for 8 seconds then switches to date for 2 seconds. Provisions are made within the chip to force display of either time or date as requested. This is an important feature for operation of the DDTMG.

The clock uses internal circuitry to keep track of the month. It also keeps track of how many days will need to be counted before advancing the month counter. February 28 always advances to March 1, except the designers of the chip allow February 29 to be set manually into the counter for leap year. This is only 1 day in 4 years when manual setting of the clock will be required.

The 7001 chip is designed to drive either 4 or 6 seven segment LED readouts. The first 4 LED readouts indicate hours/minutes or months/day. The fifth and sixth digits are used in time mode only and indicate "seconds." The "seconds" digits are not used in the Baudot converter. Information is taken from segments A, B, E, F and G to feed to the Baudot converter. Signals indicate which digit is being strobed, and are required by the de-multiplexer.

The circuit shown has driver transistors on the segment lines to provide additional drive to the LEDs. In the first version of the clock the LEDs were not bright enough to suit me so this slight addition was made. This portion of the project can be built as a stand-alone electronic clock and would be a great addition to most shacks.

Parallel to Serial Converter

The function of this unit is to take parallel information from the memory bank and present it in serial form to the RTTY

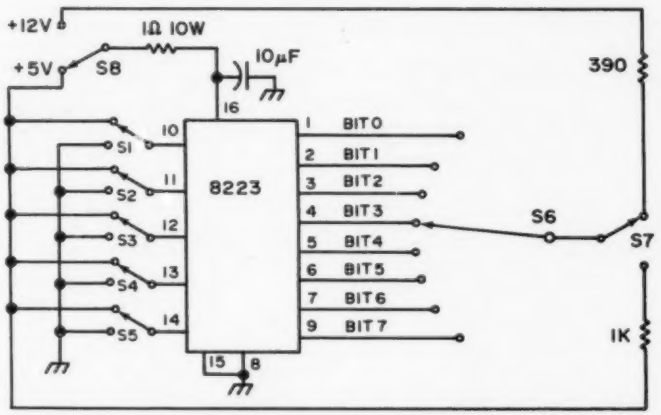


Fig. 2. 8223 programmer. Circuit source: Signetics Data Book, *1974, pages 4-11.*

loop. The basic timing pulses come from a U12. This unit has components selected to operate at 91 Hz. U20A gates the pulses from the generator to a set of frequency dividers consisting of U1, U2 and U3. The output of U2B and U3 are connected to an 8 line to 1 line multiplexer, U4. This approach was used by K4FUP and W4VWS in their message generator I. This circuit will take the data presented to the input pins and will in sequence place successive bits on the output line to be fed to the RTTY loop for keying. The speed at which data is fed from the multiplexer is selected by section one of U9. For RTTY the output pulses are each 22 ms. For CW mode the two additional dividers are inserted in the divider chain by the switch action of U9. The speed is selected by the control line from the CW control latch (U17C and D). Each CW element will be 88 ms long. If the printer is left in lower case his speed will print a rather neat-looking string of 0s across the page as the CW ID is sent.

Sections two, three and four of U9 act as data switches to the multiplexer, chip U4. Their function is to force the start bit of each character in RTTY mode to a space, and to force the stop bit to a marking condition in RTTY mode. In CW mode information bits 0, 6 and 7 from the memory bus are switched to the multiplexer.

The circuit is placed in run mode for RTTY by actuation of RTTY run latch consisting of U17A and B. The start signal can be any negative-going pulse that reaches a level below 0.8 volts. This can be a switch closure as shown, a transistor (NPN) or a signal from some external TTL circuit.

U17C and D are similar to the RTTY run latch. Interfaces, similar to the RTTY run latch, are used for turn on. This latch when turned on will reset the RTTY latch. Provisions are made for resetting of this latch, as well as the RTTY latch from an external signal. The CW latch being turned on will fire the single shot, U5, that will allow a pre-wired address to be loaded into the memory address counter. This procedure will be explained later in the memory section.

The five data bits that represent the Baudot characters that are to be sent to the serializer, U4, are run through a five pole double-throw electronic switch consisting of

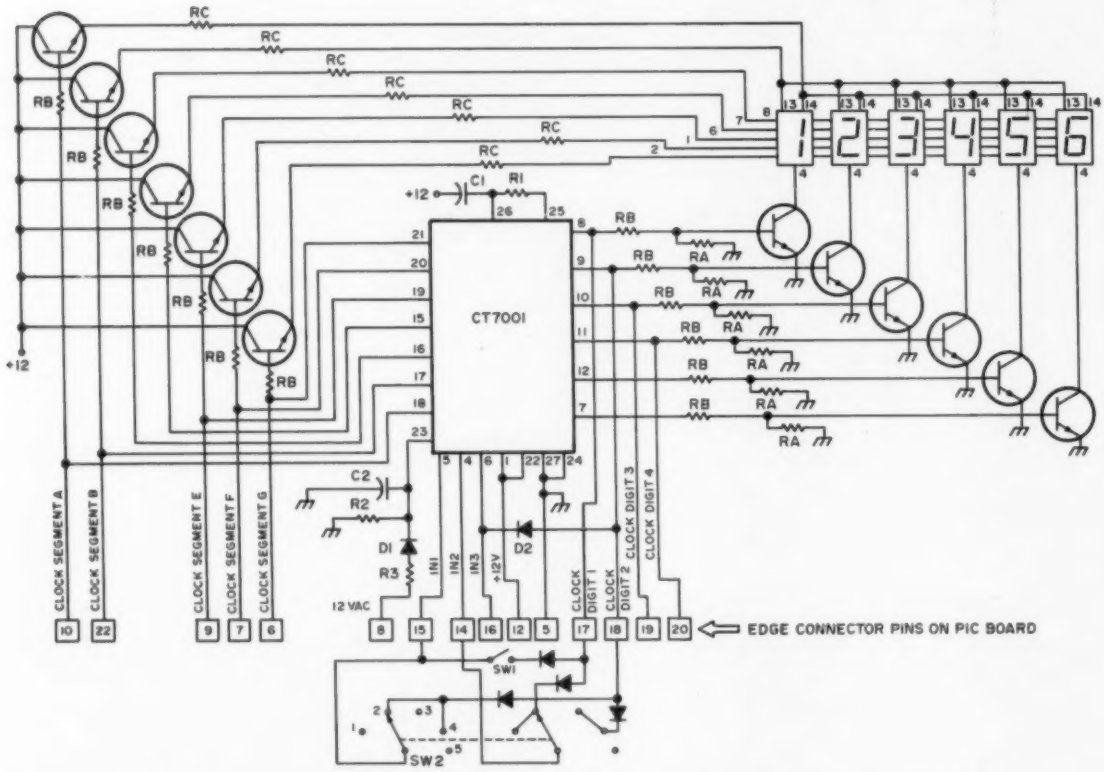
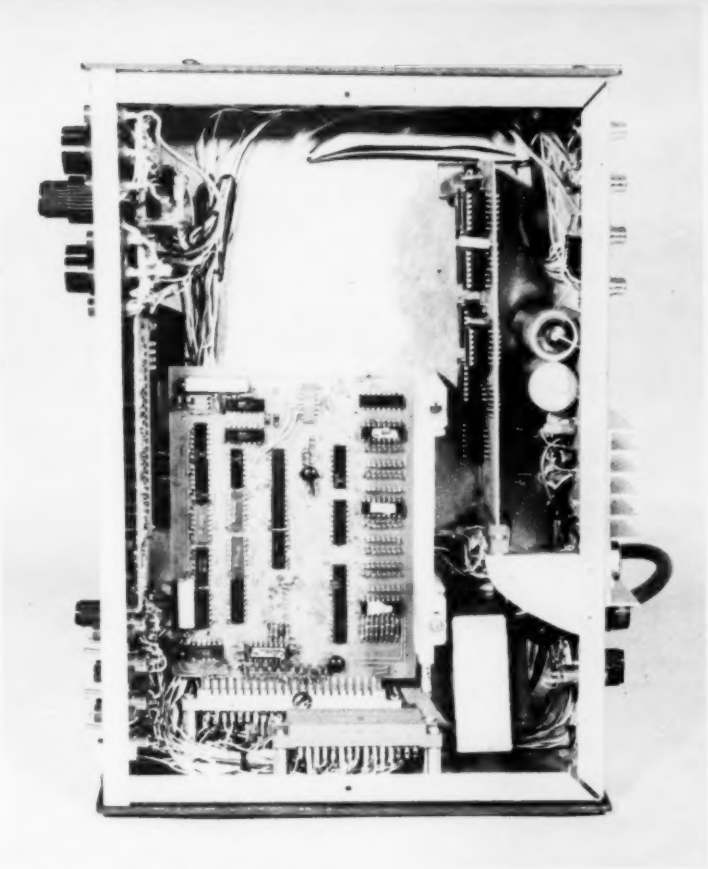


Fig. 3. Digital clock with display. Note: Pins 1, 2, 6, 7, 8, 13 and 14 from each LED readout are connected in parallel. LEDs: 7 segment, common cathode. SW2 position functions: 1 – set calendar, day; 2 – set calendar, month; 3 – set clock, minute; 4 – set clock, hour; 5 – run.

ADDRESS					DECIMAL EQUIV.
S5	S4	S3	S2	S1	
0	0	0	0	0	0
0	0	0	0	1	1
0	0	0	1	0	2
0	0	0	1	1	3
0	0	1	0	0	4
0	0	1	0	1	5
0	0	1	1	0	6
0	0	1	1	1	7
0	1	0	0	0	8
0	1	0	0	1	9
0	1	0	1	0	10
0	1	0	1	1	11
0	1	1	0	0	12
0	1	1	0	1	13
0	1	1	1	0	14
0	1	1	1	1	15
1	0	0	0	0	16
1	0	0	0	1	17
1	0	0	1	0	18
1	0	0	1	1	19
1	0	1	0	0	20
1	0	1	0	1	21
1	0	1	1	0	22
1	0	1	1	1	23
1	1	0	0	0	24
1	1	0	0	1	25
1	1	0	1	0	26
1	1	0	1	1	27
1	1	1	0	0	28
1	1	1	0	1	29
1	1	1	1	0	30
1	1	1	1	1	31

Fig. 4. Addressing sequence for 8223 memories. 0=0 volts; 1=+5 volts.



Inside view of K1ZPX cabinet. The circuit board for the clock is shown edgewise toward the front of the cabinet. The main DDTMG board is shown supported by a card guide toward the back edge. The vertically mounted board toward the rear is the timing board for the UT-4. The sockets above the DDTMG are for the other UT-4 boards. Power supply for both units is built on a small board fastened to the back of the unit.

U10 and U11 A and B. This switch is controlled by U18B, a circuit that recognizes if data should be coming from the memory or from the digital clock circuitry. More on this later.

Memory Bank

The memory bank consists of up to 8 read only memories that can contain up to 32 RTTY characters in each memory, or a CW message. The typical CW ID message used for RTTY, consisting of DE and station call, takes approximately one half of a memory chip.

The key to any memory system is in knowing where data is located. This information retrieval scheme is known as "addressing." The "addressing" scheme for this circuit consists of two 4 bit counters U6 and U7. U6 and U7A are used to address the control lines on the 8223 ROMs. The particular 8223 that is to be selected is enabled by the output of the proper line from U8. This circuit converts the binary count of U7B, C and D into a one out of eight activated line.

The RTTY message will begin at address 00000000, the address that is forced into the counter at the start of each RTTY message. The CW message can be loaded at any convenient address, preferably at a high address in the scheme. That starting address of the first character of the CW message is "wired" to the input lines of the counter. For my generator the CW message is contained in the last chip in the memory bank, so starts with address 11100000. To place this address into the address counter the preload pins of U6, A, B, C, D, U7A are "wired" to ground. The preload pins for U7B, C and D are "wired" to plus 5 volts through a 1k resistor. When the CW message latch is turned on, U5 fires and loads the "wired" address into the counter. The preload pins have been brought to the edge connector of the circuit board used for this project for ease of wiring and to allow later expansion of control circuitry to increase the flexibility of this unit.

The output of the memory bank will be used 3 different ways. First, bits 1, 2, 3, 4

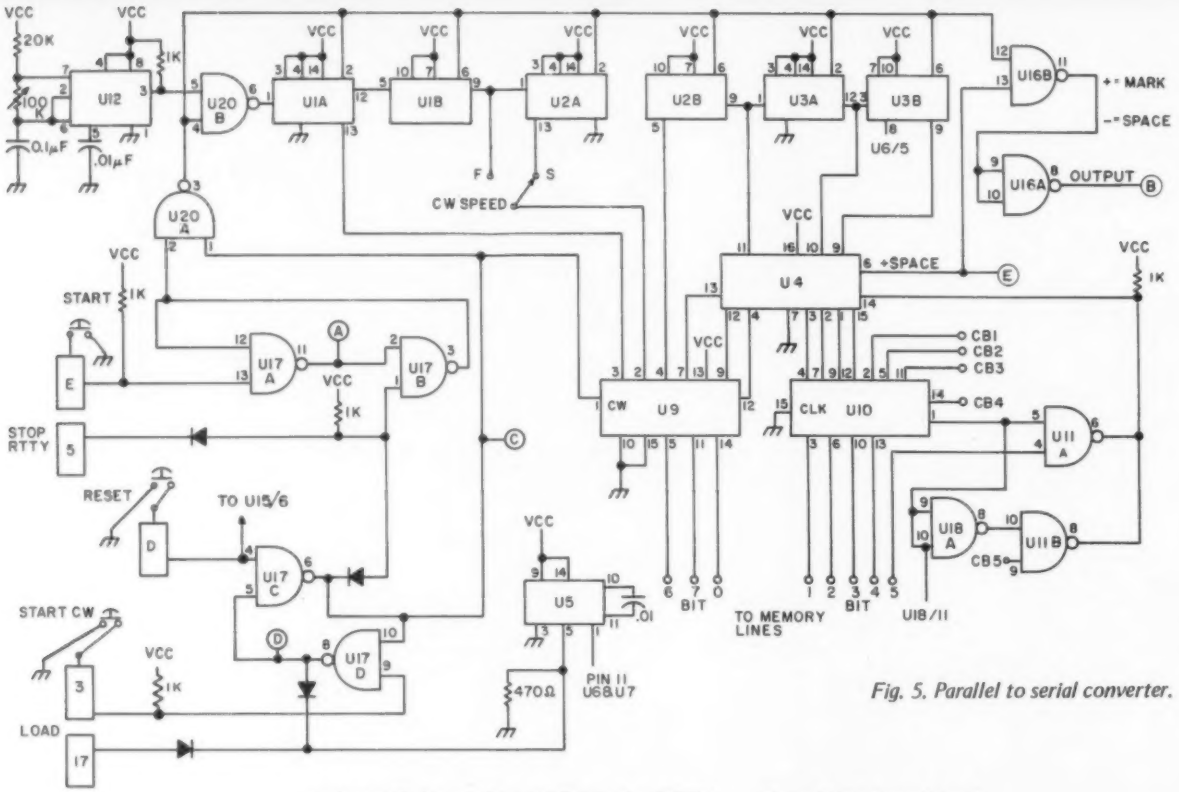


Fig. 5. Parallel to serial converter.

and 5 will be used to indicate the RTTY message to be sent. Second, all bits will be used to encode the CW message; and third, in RTTY mode when bit 0 is coded as a "1", the memory will be used as a control function generator. Also, if bits 6 and 7 are "1"s when in the RTTY mode, the generator will change to CW mode and load the "wired" address into the address counter indicating the starting address of the CW message. When in CW mode the recognition of bits 3, 4, 5 and 6 will indicate the end of the CW message. These end sequences are recognized by U21 and U15 respectively.

Translator/De-Multiplexer

The function of this circuit is to select the proper digit from the digital clock, translate the seven segment code (only five segments used in the translator) for that digit into RTTY Baudot code, place it into latches and switch it onto the serializer input lines. Let's look at what the circuit does to accomplish these functions. To signal the circuitry that a RTTY character is required from the clock, bit 0 in the memory is coded as a "1". U18B combines the plus on the bit 0 line and the RTTY latch being "on" and forces the switch U10 to take its output from latches U14 and U19. The information that is resident in the latches comes from the translator U22. The translator is available from Kelly Associates.*

The clock segment information is being changed at better than 100 kHz for each of the digits. To determine when the proper digit is available at the output of the translator, U22, we need to look at a bit more of the control circuitry. Again, in the mode of operation when the clock information is to be sent, the memory bank is being used as a control memory. As a result, the data from the memory that is usually sent to the serializer is "unhooked" since U18B has detected that we want a digit from the clock/calendar. To tell us which character is required, bit lines 1, 2, 3 and 4 are used to select which clock character will be gated to the latches U14 and U19. Let us see how the circuit operates. First, we decide that we want to "print" digit 1 from the clock. (This is the tens position of the hour or month.) We code bit 0 and bit 1 in the memory as a "1". U20C will now have pin 13 positive. When clock digit 1 (from the digital clock) goes positive, indicating the information on the segment lines is the data for digit 1, the output of U20C goes negative, forcing the output of U13 positive and firing the single shot, U30. This "opens" the gate on U14 and U19 and allows the data that is on the

*Kelly Associates, P.O. Box 2100, Glenbrook CT 06906.

output of U22 to be placed into the latches. Once this data is loaded, it is available for serializing through U4. The other digits are selected in a similar manner by gates U20D and U18C and D.

There are two additional sets of circuits that make the interface work properly. First, let's see how we select either time or date. Since digits 1 through 4 can be either time or date, the select circuits U20C and D and U18C and D are used for both outputs. The real trick is to force the clock circuit into either time or date mode as required for your printout. To do this we use a pin on the clock chip called IN3. If this pin is driven plus at digit 3 time, the clock will display time. If driven plus at digit 4 time, the date will be displayed. If you want to display time, code bit line 6 as a "1". This line being plus along with clock digit 3 being plus will gate U11C and its output will go negative. When it does, up goes the input on IN3, and up comes the time. Bit 7 does the same thing for date. To keep the clock from really showing funny numbers during a CW message when bits 6 and 7 are used as data bits, Q2 was added to make sure the output to IN3 would stay at ground potential.

To be able to set the last digit of the year for the readout the U16D circuit was added. When you want to print out the last digit of the year, place bit 0 and 5 at a "1" level. This forces the data to come from latches U14 and U19. However, bit 5 deactivates the translator U22. Instead of translating a character from the digital clock, all input lines to U14 and U19 will go plus. To input data, the output of U16D is connected to the bits required to represent the digit required. For 1975 the "5" is coded by connecting a diode as shown between the U16D output and the input to the 5 bit latch. For next year when a 6 is needed, diodes will be required between bits 1, 3 and 5. The first digit of the year data must be coded in the 8223 memory.

The input of the data from the clock is translated to TTL level signals with a resistor network consisting of a 2.2k resistor in series with a 1k resistor and taking the signal from the junction. This design is not optimal for the design criteria for TTL logic, but has worked very successfully in this circuit.

The output of the circuit is interfaced to the ST6 with a very simple circuit. The output of U16A is run to an NPN transistor

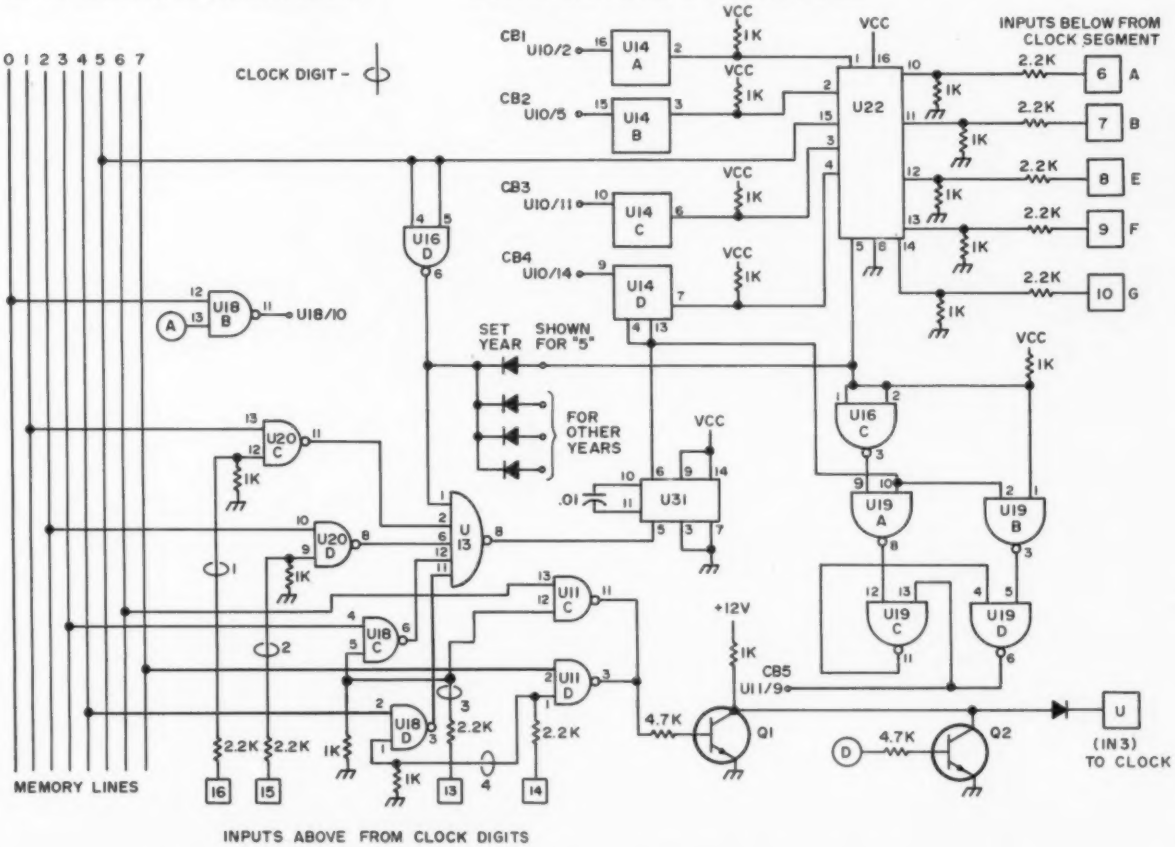


Fig. 6. Translator/de-multiplexer.

with a 4.7k resistor in series with its base. The collector circuit is connected to the base of the loop-keying transistor. Works every time.

Power Supply

The DDTMG requires a power supply that can deliver 5 volts at 1 Amp and 200 mA at 12 to 18 volts. The 5 volts requirement is best met by using the very conveniently packaged LM309K. Be sure to attach the LM309K firmly to the cabinet to aid in dissipating the heat from the circuit. A small U-shaped fin would also help to keep the unit cool. Diodes DX, battery BT and resistor R1 in the power supply can be eliminated. These components allow the clock chip to continue operating should ac power fail. The battery will be charged whenever the ac power supply is operating. It is advisable to check the current flow into the battery when fully charged to assure yourself that it is not exceeding 1 or 2 mA when the nicad batteries have reached full charge. Adjust R1 to set this current level.

Programming the 8223 Memories

When unprogrammed 8223 ROMs are purchased, all of the outputs will be at a "0" level. A small programming fixture as shown in Fig. 2 is all that is required to program these units. To program the ROMs I use the following procedure as outlined in Signetics Data Handbook.

1. Ground pin 8, and remove Vcc from pin 16.
2. Remove all output loads.
3. Ground the chip enable line, pin 15.
4. Address the location to be programmed by selecting the address using the five SPDT switches. For address 00000 all switches will be at the ground level. Address 00010 would be selected by placing switches 1, 3, 4 and 5 at the ground level and switch 2 at the plus 5 volt level. In the addressing scheme, bits are addressed from right to left. The right most bit represents the least significant bit in the address and the left most bit represents the most significant digit. The table in Fig. 4 shows the sequence of addresses and their equivalent decimal value. Remember when programming a sequence of characters, the order of message must start in the least significant position of the memory and be located in increasing addresses.
5. Apply plus 12 volts to the pin to be programmed through a 390 Ohm resistor. One bit is programmed at a time. The bit to be programmed is selected by switch 6. This technique will be applied only to those pins that must be at a "1" level at the end of the programming process.
6. Apply plus 12 volts to pin 16 for as short a period of time as possible.

Completed clock. This control unit built by K1ZPX houses the DDTMG, a UT-4, the necessary power supply, and switching circuits to select interfaces to several receivers and transmitters.

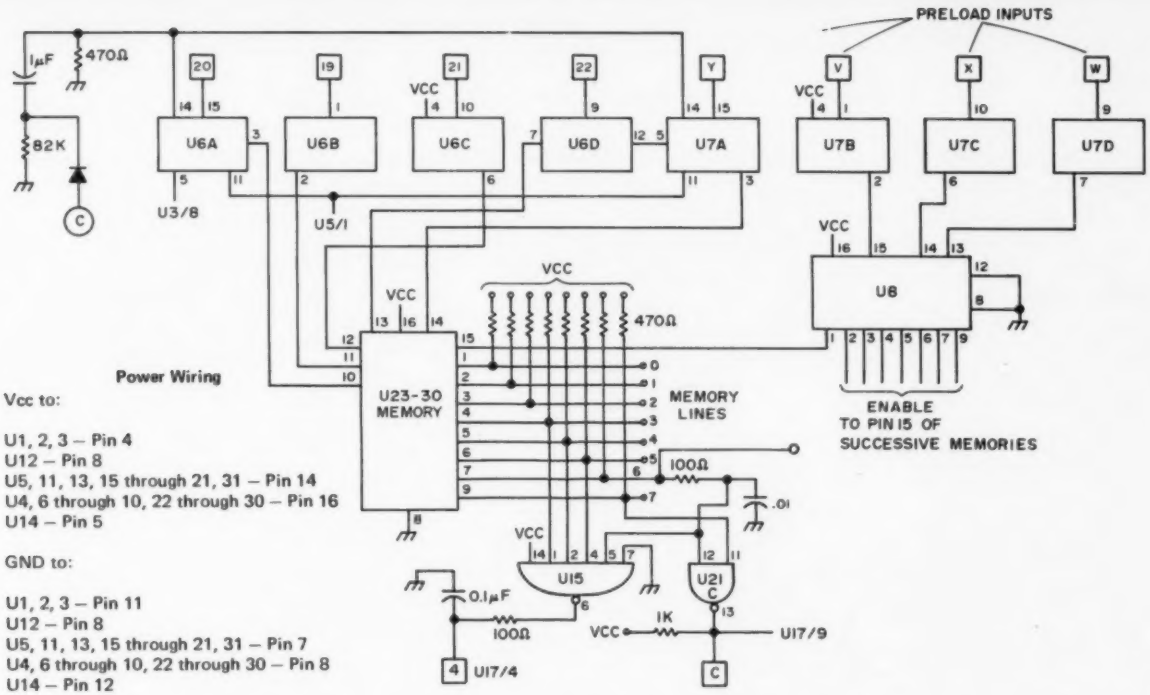


Fig. 7. Memory bank. Note: .01 bypass required for every 4 chips between Vcc and GND. U23 through U30 are 8223s in parallel, with only one shown. Only pin 15 is connected to separate enable lines.

7. Verify that the bit has been programmed by checking the output voltage across the 1k resistor with switch 7 in the verify position.

8. Continue to the next bit to be programmed at this address. When all bits at an address have been programmed and verified, advance the address and program the bit pattern for that address.

9. If during the verification process, a bit has been found to be not programmed, repeat steps above.

This process is quite simple, but requires a great degree of attention. One bit in the wrong position or address and the chip is useless. There is no way of returning a bit to the "0" level once it has been programmed.

If you prefer not to program your own chips, Kelly Associates offers the service of programming to your specifications at a very nominal fee. A self-addressed note to them will bring convenient forms to help you lay out your message.

To prepare the data to be programmed into the memories, we will look at the RTTY message differently from the CW message. All RTTY information will be contained in bit positions 1 through 5. Bits 0, 6 and 7 are used as control functions. As a result it is important to keep these bits 0, 6 and 7 as zeros during the programming operations. The bits will be set at the one level for each space and at the zero level for each mark. The start and stop pulses will not be programmed. They are inserted automatically by U9. Any handbook such as "Ham RTTY" will show the code required.

Let's look at an example. To code the letter "A" into the first address of a memory, we progress as follows. Select the first "address" in the memory. This is represented by address 00000. The Baudot representation of the letter "A" is

MARK MARK SPACE SPACE SPACE.

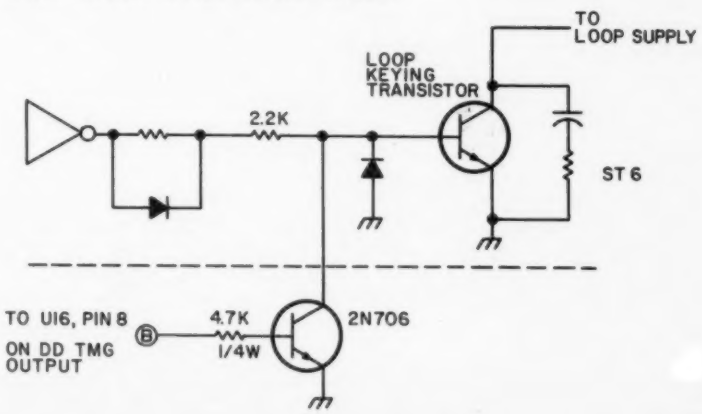
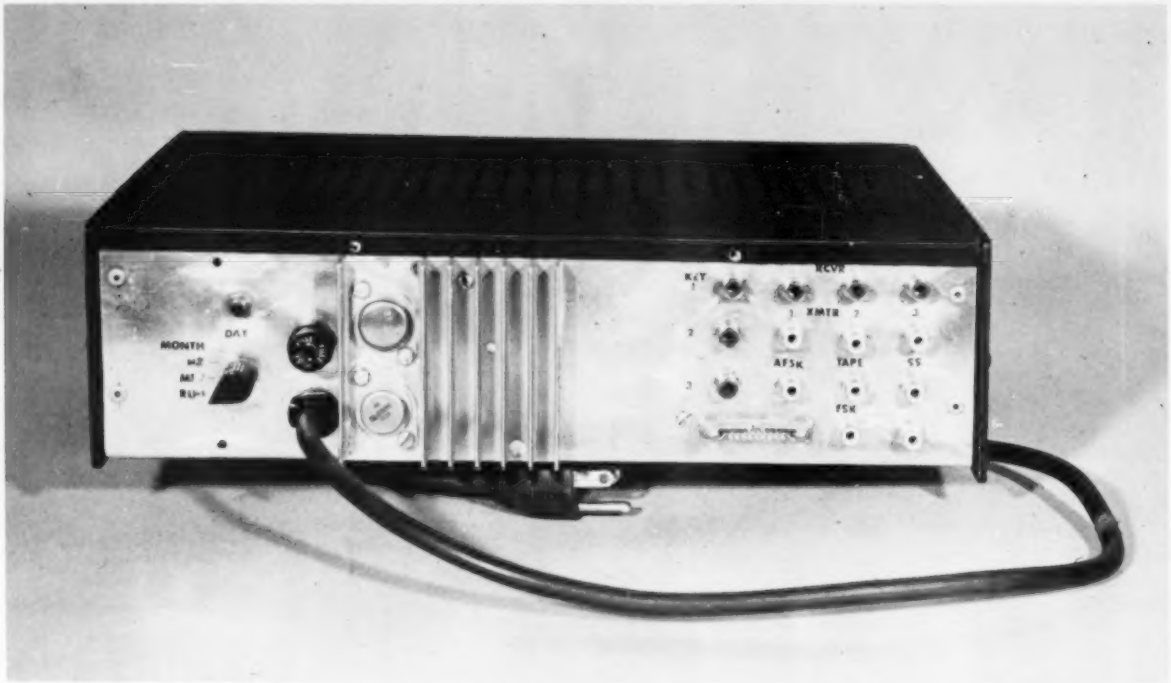


Fig. 8. Interface to ST-6.



Rear view of K1ZPX DDTMG. The push-button and 5 position rotary switch on the left side of the panel is used to set the time and date on the clock.

This means that in the memory we want bits 1 through 5 to be set as follows:

bit 1	bit 2	bit 3	bit 4	bit 5
0	0	1	1	1

Again, remember bits 0, 6 and 7 will remain at 0 level. After completing the "writing" of the first character, advance the address to 00001 and program that character. Continue advancing the address switches to complete the message.

Programming of the time and date feature requires using the control bits 0, 6 and 7. Let's review what each of these bits controls.

Bit 0 at the 1 level in RTTY mode indicates that the data to be "printed" should come from the clock generator circuit rather than the memory bank. This is accomplished with the switch U10 and U11 A and B. When bit 0 is programmed to the 1 level, bits 1, 2, 3 and 4 select which of the clock characters are to be printed. Bit 1 selects the tens position of the month or hour – bit 2 at the 1 level selects the units position of the month or hour. Bit 3 selects the tens position of the day or minute, and bit 4 selects the units position of the day or minute. Bit 6 programmed at the 1 level will force the clock into the clock mode and bit 7 programmed to the 1 level will force the clock to display the date mode. To "print" the first digit (tens position of the hour) the following character would be in the selected address:

bit 0	bit 1	bit 2	bit 3
1	1	0	0

bit 4	bit 5	bit 6	bit 7
0	0	1	0

To select the digits of the time output, successive addresses in the memory would be identical to the above line except the 1 in bit position 1 would be replaced by A 0, and the 1 would be placed successively in positions 2, 3 and 4. To indicate that a TTY message is ended, bits 6 and 7 are both set to the 1 output.

Programming the Memories for CW

In the CW mode all 8 bits of the memory are used in coding the message. The message is laid out as shown in Fig. 1. Each Morse element is coded as a "1". A dot consists of one Morse element, a dash consists of three Morse elements. Inter-element spaces require one Morse element while inter-character elements require three Morse elements. The spacing between words is equal to seven elements. All spaces are programmed as "0" level in the memory.

The message is started at the address chosen for CW message. Bit 0 represents the first Morse element. I recommend at least

one address (8 bits) be left at the zero level to set off the CW message at the beginning and end of message. The first bit of the message is placed in the bit 0 position. The next element is placed in bit 1 position and so on through the memory. When the bit 7 is programmed, advance the address one count and continue the message starting at bit 0 for that address. Progress through the entire message until the complete CW message is programmed. Then allow at least one full address as blanks (0) level, then code the end of message character. This character consists of the 3, 4, 5 and 6 bits being coded as "1"s.

Construction

The easiest method of construction uses the circuit boards available from Kelly Associates. The plug-in clock and message generator board allow easy building and a great deal of flexibility in housing the circuitry. The photographs show one packaging possibility used by K1ZPX in a complete control console for his RTTY station. The original circuit was developed with hand-wired boards and performed very well. Adequate bypassing from Vcc to ground is one of the secrets in getting TTL logic to work. A .01 uF disk ceramic for each 4 TTL circuits is adequate.

Included in K1ZPX's control box is a Hoff designed UT-4, power supplies for both units and switching circuits to select up to 3 transmitters and receivers. There is one interconnecting cable to the ST-6 that contains all the control signals required for both circuits.

Testing

First, get the digital clock working. This is easy since there is very little circuitry for this unit. The message generator board is not required for this step. Be sure the voltages are proper to the clock. Check out each switch setting to be able to set the time and date and watch it operate. The seconds should reset to "00" when the time is selected for setting. When the setting switch is placed in the run position, this counter should begin counting. When the count reaches 8, the chip should switch to date mode. After two seconds in this mode, back comes the time and the seconds counter should now begin counting at 10. Just one word of caution, the clock chip is very sensitive to static discharges. Don't solder on the circuit board or its interconnections with the chip in the circuit. Take it out and place it in its shipping pad to act as a discharge preventer. Also use a socket for the chip.

After the clock is working, remove the clock board from its socket and insert the message generator board into its socket. With power applied, check the output of the U12 clock and set its frequency at 91 Hz. A counter is best for this, but a scope will do using 60 Hz as a reference signal. Place the CW memory in its assigned location. This location will be consistent with the address "wired" into the address counter preload. The RTTY memory must be plugged into the first position on the memory bank. Pressing the CW start switch should force the address wired into the preload into the address counters U6 and U7. The counter should advance and the CW message should appear at the output pin. When the message is complete, the reset character, bits 3, 4, 5 and 6 at the "1" level will reset the CW latch (U17 C and D) off.

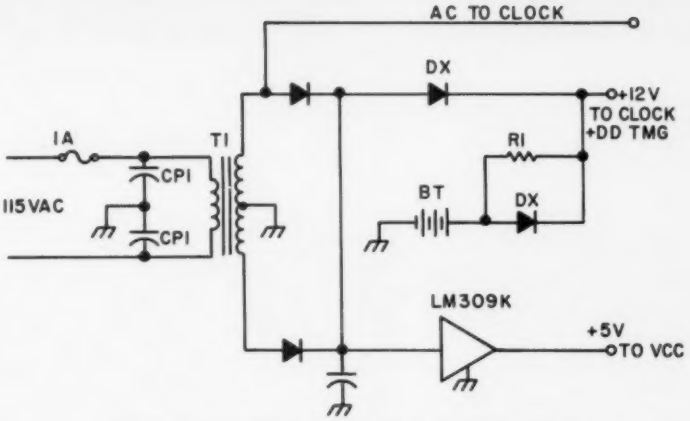


Fig. 9. Power supply, with back up power for clock.

Parts List

Fig. 2.

S1-S5: ADDRESS select switches, SPDT
S6: 8 position, 1 pole rotary
S7: Program/verify switch, SPDT
S8: Program switch, SPDT momentary contact P/B

Fig. 3.

RA: 22k, ¼ W
RB: 4.7k, ¼ W
RC: 220 Ohm, ¼ W
R1: 15k, ¼ W
R2: 27k, ¼ W
R3: 5.2k, ¼ W
C1: 150 pF
C2: 0.01 uF, disc
SW1: SPST mom. con. P/B
SW2: 5 position, 2 pole rotary
All transistors: 2N706

Fig. 5.

U1, 2, 3: 7473
U4: 74151
U5: 74121
U9, 10: 74158
U11: 7403
U12: 555
U16, 17, 20: 7400

Fig. 6.

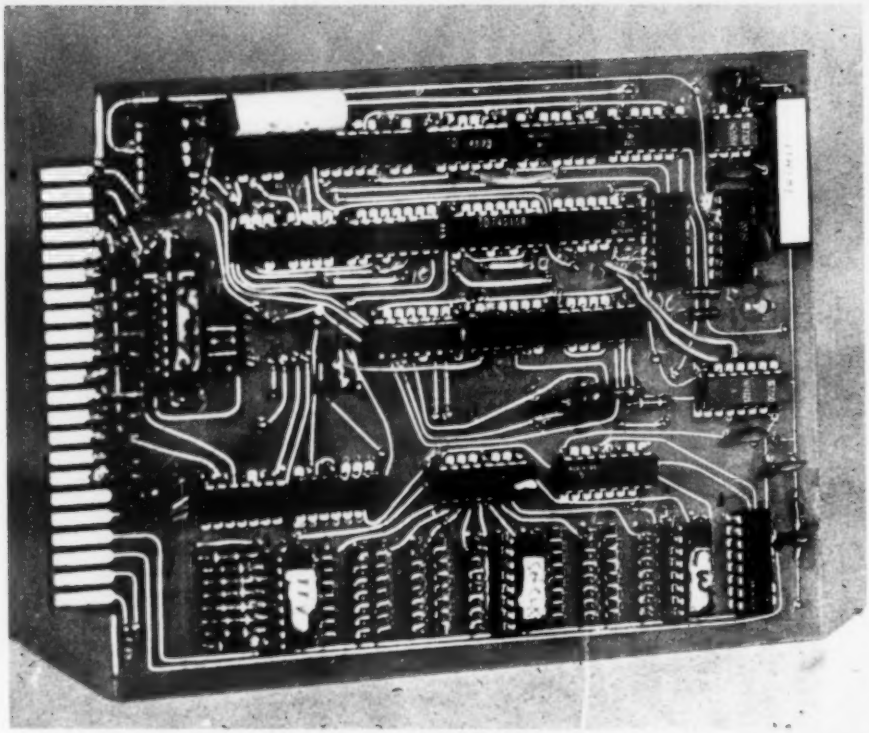
U11: 7403
U13: 7430
U14: 7475
U16-20: 7400
U21: 7401
U22: DDTMG
U31: 74121

Fig. 7.

U6, 7: 74193
U8: 7442
U15: 7420
U23: 8223
Q1, 2: 2N706
All resistors: ¼ W, 10%
All caps below 0.5 uF: disc ceramic
All caps above 0.5 uF: 12 V electrolytic
All diodes: general purpose germanium

Fig. 9.

CP1: 0.01 uF disc at 600 V
BT: 450 mAh 12 V Nicad
R1: 500 Ohm 2 W carbon
T1: 24 V ac 2 A center tapped
All diodes: 1 A 50 V piv rectifiers



Circuit board for the DDTMG. The pot on the upper right sets the basic timing for all circuit operations. Eight sets of molex pins are used to make the memories plugable across the bottom of the circuit card.

When this circuit is working, it is time to try the RTTY message. With the digital clock removed, the RTTY message should print with blanks in the place of the time and date digits. When the end of the TTY message is reached, the TTY reset character will force the CW latch on and the CW message will be sent.

When the above circuits are checked out, it is time to check out the time/date de-multiplexer. First, using jumper wires, tie the clock digit lines to plus 12 volts. Then select the following clock segment lines and tie them to plus 12 volts. The digit shown should appear:

Seg A	Seg B	Seg E	Seg F	Seg G	Number
1	1	1	1	0	0
0	1	0	0	0	1
1	1	1	0	1	2
1	1	0	0	1	3
0	1	0	1	1	4
1	0	0	1	1	5
1	0	1	1	1	6
1	1	0	0	0	7
1	1	1	1	1	8
1	1	0	1	1	9

When all of these tests are completed, shut down power and plug in the clock. When power is first applied, the clock will indicate all 8s. Try the message generator in RTTY mode and see that the 8s print properly. When they do, go ahead and set the correct time and date in the clock. Pressing the RTTY start switch should give you that desired message we all wanted when we started the project. Out will come the time and date, providing the programming of the chip was correct.

This circuit has been operating for about 8 months now without a circuit failure. It has really been handy to use with the relay and WRU system at W1HAB. With an external programmer the unit becomes a very versatile unit to send up to 8 different messages at the touch of a button.

Special thanks are due to WA1DQL, who provided the motivation to do the design, to K1ZPX, who checked out the prototype, and also to K2USG, for the photographic work. ■

Reference

"A TTL Message Generator for RTTY and CW," Bell, James E., and Schmidt, Fred H., *QST*, November, 1973, p. 23.

ME-3 microminiature tone encoder

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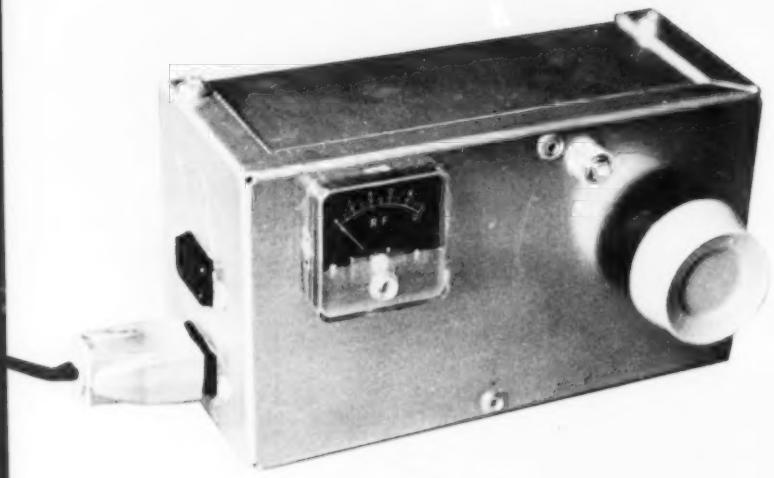
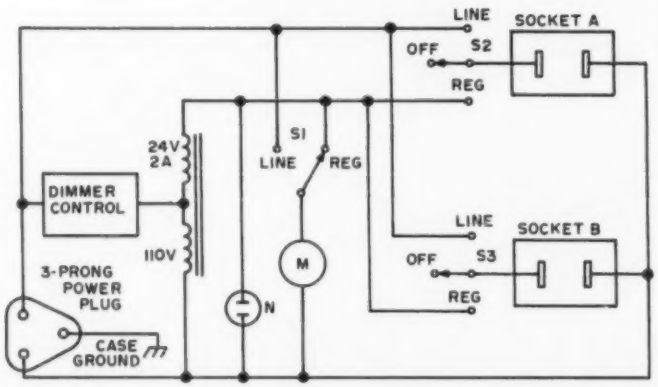


by
Peter A. Lovelock K6JM
1330 California Ave. #307
Santa Monica CA 90403

The Solder Master



For contemporary assembly projects I use popular, screw-in element and tip soldering irons which, with tweezers and magnifying lenses, are tools of the micro-component age. Frequently I use two irons at the same time – a 50 Watt heavy duty for large joints and a tiny tiplet for compacted PC boards. Frustration is maintaining both irons at proper temperature. The big element, left idle for any time, toasts its solder tinning and threatens self-destruction, requiring unplugging. The tiplet dissipates heat too fast for more than one connection, involving impatient recovery time.

At the aerospace plant where I do my thing, our young ladies at each assembly

station have neat, solid state soldering iron control units with voltmeters for adjusting desired element temperature. Just what I needed. I checked the price of these commercial units with our purchasing department. Following a brief respite in the first aid station, I regained my composure and applied some ham thinking for a better solution.

The el cheapo answer was the commonly available "light dimmer," rated at 600 Watts and solid state at that. Lucky I had one in the junk box that would tame the heavy duty iron. But while lowering the voltage, why not also boost it briefly to help the tiplet along? A 24 V, 2 Amp filament transformer solved this.

The photos show how the major items were squeezed into a 5" x 3" x 3" aluminum utility box with two outlet sockets, in the initial version. An available miniature meter (yes, the dial does say "RF") was pressed into service, modified with bridge rectifier and series resistor to read zero to 1.0, for reference. This worked great, but had some inadequacies such as how to control the irons separately, which was soon taken care of with a few more parts.

The schematic gives the final story, which included adding three small toggle switches not apparent in the photos. I also splurged on a new meter of the same size, reading 0-150 V ac. The transformer primary and secondary windings were connected in series to make an auto-transformer, having checked proper polarity connection so that with 110 V ac across the primary, 130 V ac was measured across the combined windings. The "dimmer" control adjusts line voltage to the primary so that regulated output to the sockets can be varied from 0 to 130 V ac with the front panel knob. S2 and S3, miniature single pole, triple throw (center position OFF) toggle switches, were installed right below the meter, in line with their respective sockets. These allow either socket to be switched to regulated or line voltage, or "off," independently. S1 was rather gilding the lily in switching the meter to read regulated supply, or double as a line voltage monitor. This miniature SPST switch was located immediately to the left of the meter. Due to the pulsating waveform output from the dimmer control, voltmeter readings are not really accurate rms, but close enough for reference adjustment.

Now I keep the larger iron happy idling at 70 V, while using the small one switched to "line" – or switch it off temporarily, while boosting voltage to the tiplet to solder multiple joints. Start up time is reduced by briefly applying full 130 volts, but boost voltage (over 110 V) should be kept to the minimum to avoid premature element failure. And when the XYL sounds chow call, both irons can be left idling at approximately 60 V, for fast reheat upon return. The neon pilot light, being connected across the regulated voltage, extinguishes at about this control setting. If you set the control where the pilot is flickering, this is just right for keeping the irons warm.

Note I finally use a three wire power line input to provide ground to the metal case. This is not only a desirable safety feature, but also provides shielding for noise spikes emitted from the dimmer control. Should you use grounded tip irons, you will also want to substitute 3-prong outlet sockets rather than the 2-prong types.

When the XYL sounds chow call, both irons can be left idling . . .

You may also find some other handy applications for this voltage controller around the shack – but don't exceed the transformer wattage rating by plugging in the coffee pot. I had most of the parts on hand. If all parts are bought new – and dimmer controls which retail for around $5.00 can be found on sale for as low as $2.98 – the total cost even in this age of inflation should not exceed $15.00.

One last warning. The push switch built into the dimmer control serves to turn the regulated supply on and off. But, while plugged in, the unit will furnish voltage to the sockets when either S2 or S3 is switched to line. Inadvertently leaving the irons on is avoided by leaving S2 and S3 at center position OFF when not in use.

Anyway, shutting off the main bench safety switch, which controls all outlets, is double protection. You do have a main safety switch in your shack, don't you? ■

Internal view.

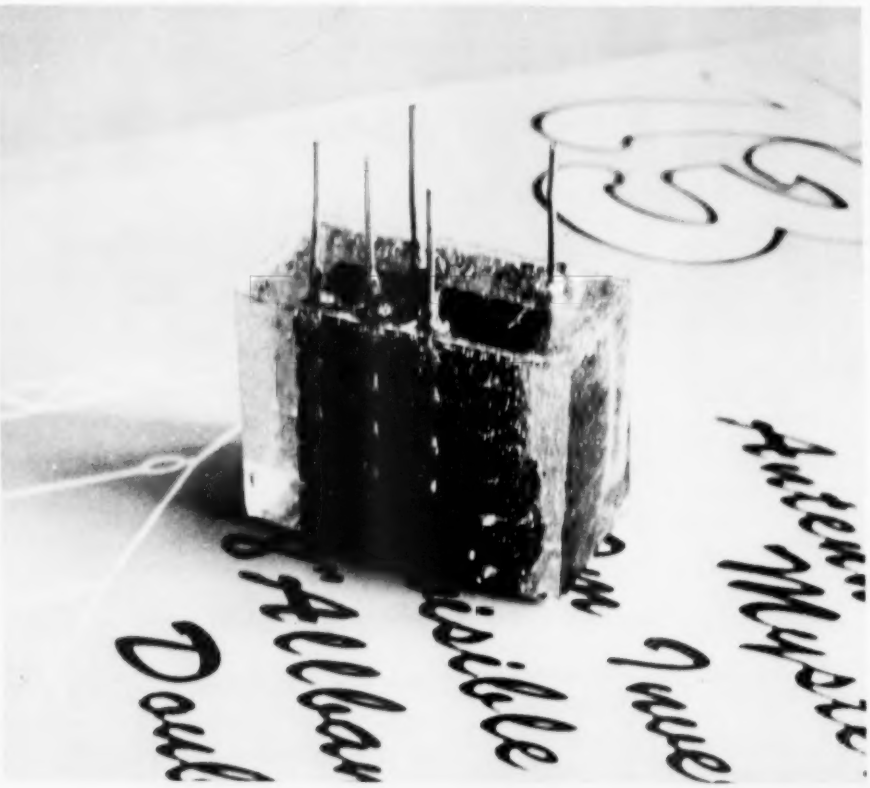
Stack Your ICs

by
Maj. Robt. M. Harkey (Ret.) W4CUG
1204 Dooley Drive
Charlotte NC 28212

As unlikely as it may seem, one disadvantage that the experimenter has when using and designing with integrated circuits is coping with redundancy. As an example, when designing/constructing a series of redundant circuits from ICs such as frequency dividers for the timebase of a counter, the layout of the circuit board becomes a formidable task. As far as I'm concerned, anything that can be done to simplify board layout is well worthwhile — and therein is the purpose of this article.

A very basic block diagram consisting of a divider circuit for counting down a 10 MHz crystal oscillator to 1 Hz is shown in Fig. 1. Since in this case there is no requirement for reset of the dividers, the circuit boils down to only four connections: plus 5 volts, ground, input and output. Now if you'll look at a typical counter circuit board, you'll realize the complex circuit board that it takes to achieve the desired four connections. So the question is: How do we integrate the integrated circuits? I think I have one solution.

Using the most common decade divider, the 7490, the solution is relatively simple: You just stack the ICs one on top of the other, make the necessary IC to IC connections, and pot the entire stack of ICs with a



And Pot 'Em

few external leads sticking out. Sounds good, doesn't it? But the "doubting Thomases" among you probably think there are a few catches – and there are. First and probably the greatest danger is the possibility of one of the 7490s becoming defective and thus ruining the usefulness of the entire stack. Based upon my experience, this is highly unlikely if care is taken with the supply voltages. The 5 volt supply should be well regulated and in no case should the supply voltage be reversed to the IC stack. Although I have gotten away with this a few times with individual ICs, the usual result is destruction of the IC. Another consideration is heat dissipation. The 7490s run relatively cool in normal operation, and so far I've experienced no difficulty with stacking and potting seven of them. The potting material obviously helps with the heat dissipation, but to be absolutely sure, you could include a heat sink or fins when potting the stack. The last consideration for the stacking process is how to make the many interconnections to seven 7490s stacked in a group which is no more than 1¼ inches high. Very simple task with the 7490. Referring to the 7490 pin connections in Table 1, you will note that pins 2, 4, 6, 8, 9 and 13 require no interconnections. Also, the following pins can be directly interconnected between all ICs and constitute a ground connection for the entire stack: pins 3, 7 and 10. Thus the only indirect IC to IC connection that must be made is between pins 1 and 12 to connect the inputs and outputs together. In addition, pins 11 and 14 must be connected on each IC to tie the divide by 2 and divide by 5 sections together. (This method provides a symmetrical output from each IC.) So, if you're still with me, let's stack two 7490s step by step; stacking any number can then be accomplished by repeatedly following these steps.

On each IC to be stacked, bend pins 2, 4, 6, 8, 9 and 13 straight out and cut them off flush. This action deletes unneeded pins and permits more room for other connections. Bend pins 11 and 14 in and flush up against the bottom of the IC body. Using a small piece of hookup wire, connect pins 11 and 14 together and carefully solder the connections. Now bend pins 1 and 12 straight out and cut off the tip ends of the pins. At this point, you should have 2 pins bent under the IC and connected (11 and 14), 2 pins bent out from the IC (1 and 12), 6 pins cut off (2, 4, 6, 8, 9 and 13), and 4 pins remaining in their original position (3, 5, 7 and 10). Now stack IC2 on top of IC1. On IC2, pins 3, 5, 7 and 10 should slide down smoothly over these same pins on IC1. Solder (carefully) pin 3 on IC2 to pin 3 on IC1 and do the same for pins 5, 7 and 10. Assuming now that the bottom IC1 is to be the input divider, use a small piece of hookup wire to connect pin 12 on IC1 to pin 1 on IC2. Using the foregoing procedures, continue to stack IC3 on top of IC2, IC4 on top of IC3, etc., until you have the desired number of dividers connected together. After you've finished the last IC, connect pins 3, 7 and 10 together with hookup wire. This connection is the ground point for the entire stack. Recheck the stack for shorted pins, solder bridges, poor solder connections, etc. Extend pin connections out the side or

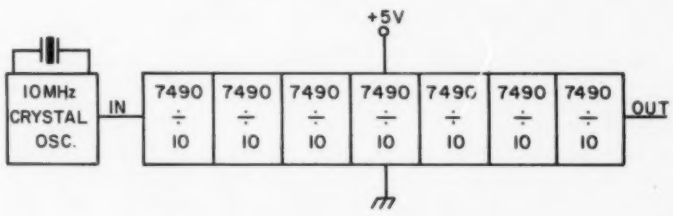


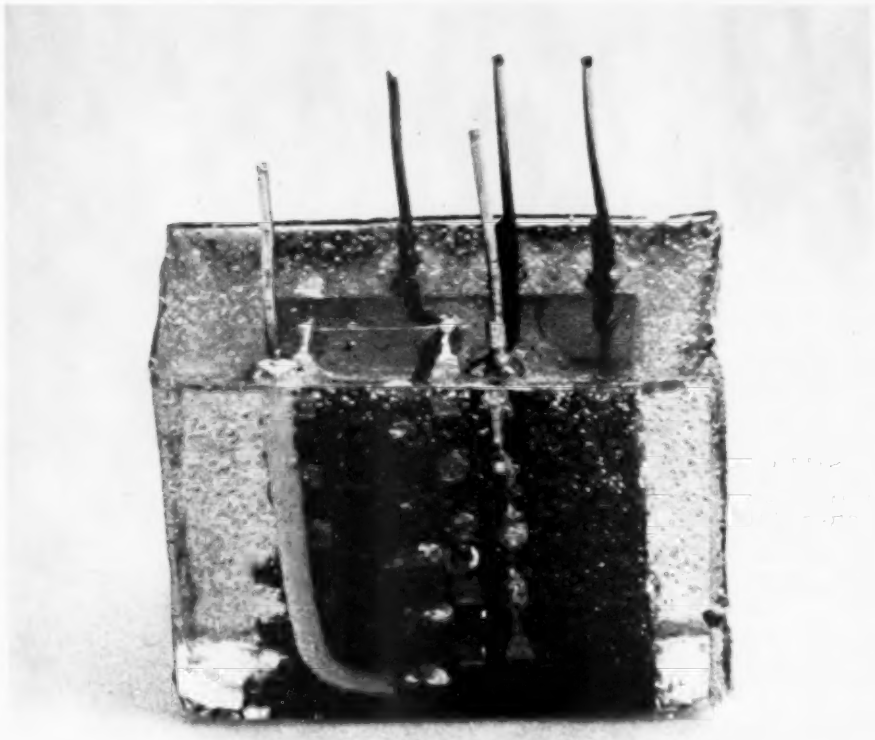
Fig. 1. Typical gate generation circuit divider for a frequency counter. With no reset requirements, only four connections are required to the decade divider circuit – in, out, +5 volt and ground. Note: For a 1 Hz count gate one additional divide by 2 stage is required.

Pin 1 – Divide by 5 input	8 – BCD output "C"
2 – "0" reset	9 – BCD output "B"
3 – "0" reset	10 – Ground
4 – No connection	11 – Divide by 5 output (BCD "D")
5 – +5 volt	12 – Divide by 2 output (BCD "A")
6 – "9" reset	13 – No connection
7 – "9" reset	14 – Divide by 2 input

Table 1. Pin connections for a 7490 decade divider. Note that the "0" and "9" reset functions have duplicate pins and only one pin is required to achieve a reset. Also, for countdown circuits, the BCD "C" and "B" pins are not required.

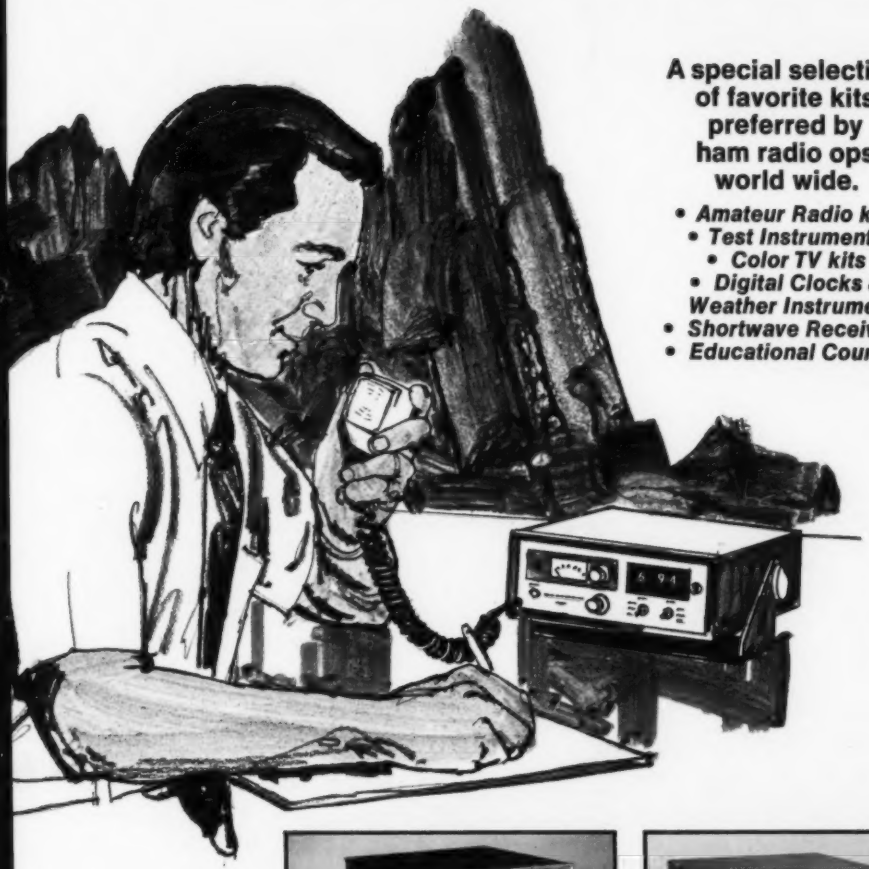
bottom of the stack using small pieces of solid hookup wire. As many connections can be made as you want, up to 16 (for a standard 16 pin DIP socket). In my case, I brought out the input (pin 1 of IC1), plus 5 volt line (pin 5 of all ICs), ground (pins 3, 7 and 10 of all ICs) and the outputs (pin 12 of IC5 and pin 12 of IC4). Two outputs were brought out in case I wanted to change the clock frequency. After you've made the pin connections, form them to fit into an IC socket, cut them off about one inch below the stack and plug them into a socket to hold their shape during the potting procedure. Now, and most important, make a sketch of the base diagram of your stack! Connect the stack to a square wave oscillator and check operation of the entire chain. After satisfactory checkout, place the stack upside down in some convenient, small container which has been lined with plastic sheet, tape or similar material. Level the container and pour it full of a potting material. I used a two part epoxy for this purpose and found that it works well. After the potting material has set up thoroughly, remove the outer container with a knife and clean up the exterior of your potted IC stack. The pins can then be trimmed to a convenient length and you're ready to plug in your integrated integrated circuit into a much simplified circuit board. My stack is 1" x 1" x 1¼" and occupies a very small space on the circuit board.

This sounds like a rather lengthy process, but after stacking one set of ICs, it becomes very easy and quick. I'm sure the IC manufacturers have comparable circuitry in one IC now but the price is probably high. With the price of 7490s now in the 75¢ area on the surplus market, this is a very inexpensive method of making circuit boards smaller and simpler. ■



This is the completed potting job. The potting material is clear and internal connections between the ICs can be seen. The pins are ready for trimming to final size prior to insertion into an IC socket or printed circuit board.

Heathkit® amateur radio mini catalog



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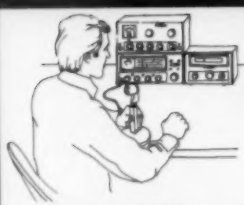

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Kit DX-60B, 24 lbs., less crystals, mailable **109.95**

DX-60B SPECIFICATIONS — Power input: 90 watts, peak; controlled carrier phone, or CW. **Output impedance:** 50-75 ohm (coaxial). **Output coupling:** Pi-network. **Operation:** CW or AM phone — crystal or VFO control. **Band coverage:** 80 through 10 meters. **Power requirements:** 120/240 VAC, 50/60 Hz, 225 watts. **Dimensions:** 6½" H x 13¾" W x 11½" D.

Heathkit 5-band receiver tunes AM, CW & SSB for just 109.95

Top performance at a modest price. Full 80-10 M coverage with each band accurately displayed on the calibrated slide-rule dial. Separate RF and AF gain controls . . . adjustable BFO for easy sideband tuning. Sensitivity of 1 μV and 3 kHz selectivity from the crystal filter deliver performance comparable to more expensive receivers. Features include built-in "S" meter . . . switchable AVC . . . front panel head phone jack . . . provision for optional HRA-10-1 100 kHz crystal calibrator. Alignment requires VTVM and RF signal generator.

Kit HR-10B, less speaker, 20 lbs., mailable **109.95**

Kit HRA-10-1, plug-in 100 kHz crystal calibrator, 1 lb., mailable **9.95**

HR-10B SPECIFICATIONS — Frequency coverage: 80 Meter Band, 3.5 to 4.0 MHz; 40 Meter Band, 7.0 to 7.3 MHz; 20 Meter Band, 14.0 to 14.35 MHz; 15 Meter Band, 21.0 to 21.5 MHz; 10 Meter Band, 28.0 to 29.7 MHz. **Intermediate frequency (IF):** 1681.0 kHz. **Sensitivity:** 1 microvolt for a 10 dB signal plus noise-to-noise ratio. **Selectivity:** 3 kHz at 6 dB down, 9 kHz at 40 dB down. **Image rejection:** 40 dB or better. **Input impedance:** 50 to 75 Ω coaxial. **Audio output impedance:** 8 Ω, or 500 Ω. **Panel controls:** AF GAIN, AC OFF-ON; RF GAIN; BFO TUNE; BAND Switch; MAIN TUNING; CALibrate; ANTenna TRIMmer; REC-STBY Switch; CALibrate ON-OFF; BFO On-Off; AVC On-Off; ANL On-Off. **Tube complement:** 6BZ6 RF Amplifier; 6EA8 Mixer Oscillator; 6BA6 1st IF Amplifier; 6EA8 2nd IF Amplifier-BFO; 6BJ7 Detector-AVC-ANL; 6EB8 1st Audio-Audio Output; 6x4 Rectifier. **Power requirements:** 120/240 VAC, 50/60 Hz, 50 watts. **Cabinet size:** 6½" H x 13¾" W x 11½" D.

80-2 meter VFO only 64.95

Ideal accessory for the HW-16 and DX-60B. Provides VFO control from 80 through 2 meters with separate calibrated scales for each band. Smooth 28:1 vernier tuning . . . temperature compensated circuitry for minimum drift. Provides 5 V rms at 3.4-4, 7-7.425 and 8-9 MHz range . . . compatible with virtually all grid-block keyed transmitters and most cathode-keyed transmitters. Alignment requires receiver of known accuracy covering 80-2 meter bands or 3.5 to 8.222 MHz.

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NEW Heathkit Handheld 2-Meter Transceiver

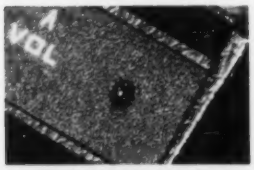
Optional Auto-Patch Encoder shown installed

Select any of 5 channels, adjust squelch and volume with convenient top-mounted controls.

Up to 10 transmit channels by switching to Simplex or Offset. —600 kHz crystal is included.

Rechargeable nickel-cadmium battery pack and charger are included. A $45 value.

Flexible "rubber duckie" antenna, matched to transceiver, is included plus jack for external antenna.



Red LED is both received signal & battery condition indicator. Pulsing LED shows Battery-Saver working.

Optional Auto-Patch Encoder permits telephone calls through repeaters. Vinyl carrying case also optional.

1-Watt out, 5 receive & 10 transmit channels plus $60 in accessories for only 169.95

More versatility & value for less than you expected. Compare the features and specs. of the new Heathkit HW-2021 to any other handheld 2-M transceiver. You'll agree it's a value that can't be matched.

One crystal does the work of two... gives you both receive and transmit frequencies for any channel. (We've even included a crystal for 146.94 to get you started). And this heterodyne circuitry is a natural for offset repeater operation... so we've also included a 600 kHz crystal in the kit together with a Simplex-Offset switch built into the case. Result? Every crystal you buy gets you one receive channel and two transmit channels. And if that isn't enough versatility, you can install a crystal with a different offset frequency. To use the full capability of the HW-2021, just buy four crystals (not pairs) in any 2 MHz segment of the 143.9 to 148.3 MHz range and you'll have 5 receive and 10 transmit channels. That's money-saving versatility.

One watt out and better audio. That transmitter output is one watt *minimum* with a 0.005% (or better) stability. And it has frequency modulation and a built-in separate microphone for better audio.

For personal and emergency communications, add "Auto-Patch." The optional HWA-2021-3 auto-patch encoder gives you access to telephone lines through repeaters (with touch-tone input) to extend the versatility of your HW-2021 at remarkably low cost. See below.

Built-in Battery-Saver, rechargeable Battery Pack & Battery Charger. The battery-saver circuit of the HW-2021 extends the battery pack's useful duty cycle on "stand-by/receive" by about 75% through a pulsing technique which actuates the receiver approx. 5 times per second. The LED indicates this pulsing. The battery pack included consists of 10 nickel-cadmium batteries housed in a plastic case with connectors molded in. When fully charged, the pack will operate the transceiver for approximately 10 hours, assuming the receiver is "on" all the time and the transmitter in use about 15% of the time. The charger will recharge the batteries fully in approximately 16 hours. Charger plug is built into transceiver case.

Compact and rugged. Textured, black high-impact plastic case. Double sided glass epoxy circuit board weighs only 2 lbs., with batteries. *Not recommended for beginning kit builders* due to its compactness. Requires small 25-watt soldering iron such as Weller W-PS for construction and VOM or VTVM for alignment.

For the best value in go-anywhere 2-M rigs, build the HW-2021.

Kit HW-2021, 5 lbs., mailable **169.95**

HWA-2021-2, carrying case & strap, 1 lb., mailable **12.95**

HW-2021 SPECIFICATIONS — RECEIVER — Sensitivity: 0.5 μV for 12 dB SINAD; 0.75 μV for 20 dB quieting. **Squelch Threshold:** .3 μV or less. **Audio Output:** .5 watts at less than 10% THD. **Operating Frequency Stability:** .005% or better. **Image Rejection:** Greater than −45 dB. **IF Frequency:** 10.7 MHz. **Modulation Acceptance:** ±7 kHz minimum. **TRANSMITTER — Power Output:** 1 watt minimum. **Stability:** .005% or better. **Oscillator Frequency:** Approximately 15 MHz. **Multiplier Factor:** x9. **Modulation:** Frequency (with limiting). **GENERAL — Speaker Impedance:** 8Ω. **Operating Frequency Range:** 143.9 to 148.3 MHz (unit will meet specifications ±1 MHz from alignment frequency within this range). **Operating Temperature Range:** +10° to +120°F (−12° to +47°C). **Operating Voltage:** 12 VDC nominal. **Size (overall):** 9¼" x 1⅞" x 3¼". **Weight (including batteries):** 2 lbs.

NEW Auto-Patch Encoder

Use it to place telephone calls through repeaters set up for touch tone input — can even be used for repeater control. 12 digit keyboard with LED keying light and 2-sided epoxy board. Designed for "2021" but can be used in others. For experienced builders. ***Available November***

Kit HWA-2021-3, 2 lbs., mailable **39.95**

HW-2021 Crystal Certificates

Crystals designed to exacting Heath standards assure optimum performance from your HW-2021. A certificate will be sent to you postpaid. You mail the certificate to the manufacturer and get the crystals postpaid by return mail.

HWA-2021-4, Crystal Certificate, postpaid **6.95**

HA-201 2-meter amplifier — 10 watts for 27.95

For everyone who owns a one- or two-watt transceiver and wants to get some extra output for very little money, the HA-201 delivers up to 10 watts for a 1½ watt input... 8 watts for 1 watt input... ideal for the HW-2021 above.

Completely automatic operation... all solid-state transmit-receive switching eliminates relays. Will withstand an infinite VSWR load without failure. Tuned input and output maximize efficiency and reduce spurious emissions. Assembly is a quick 1-2 hours, and we've included both a dummy load and a handy RF detector to eliminate the need for additional equipment other than a VTVM for tune-up. Operates from 12-16 VDC (HWA-202-1 or car battery).

Kit HA-201, 3 lbs., mailable **27.95**

New synthesized 2-meter transceiver joins

Meet the new Heathkit HW-2026 — the best value in synthesized 2-M rigs...only 289.95

• Built-in synthesizer • Built-in continuous and burst tone encoders • Automatic transmitter offset • Channel activity indicator • Synthesizer lock indicator • Lever-switched channel selection with digital readout • 5 kHz channel spacing • 8-pole IF crystal filter • Built-in speaker • Microphone & gimbal mount included

Built-in frequency synthesizer. Flip the lever switches to the channel you want...frequency readout is digital.

Synthesizer lock indicator warns that synthesizer is not locked on frequency & transmitter will not key.

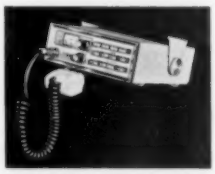
Built-in continuous & burst tone encoders are standard equipment, not extra-cost options.

8-pole IF crystal filter gives ideally shaped receiver bandpass for reduced adjacent channel interference.

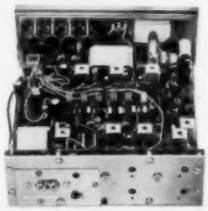
Get on "2" with the "202"...for the 179.95

A)

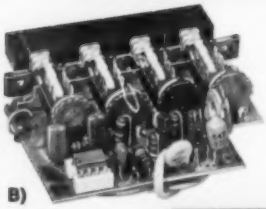
HW-202 shown with optional Tone Burst Encoder installed.



Neat mobile mount, supplied with your kit, attaches under your car's dash. Remove two knurled screws, unplug two cables, and the radio and gimbal mount can be quickly removed for safe keeping.



Open design makes the HW-202 easy to build (shown with encoder board installed). Nine built-in adjustments let you align without special instruments.



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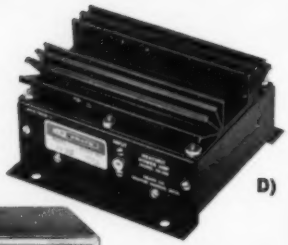

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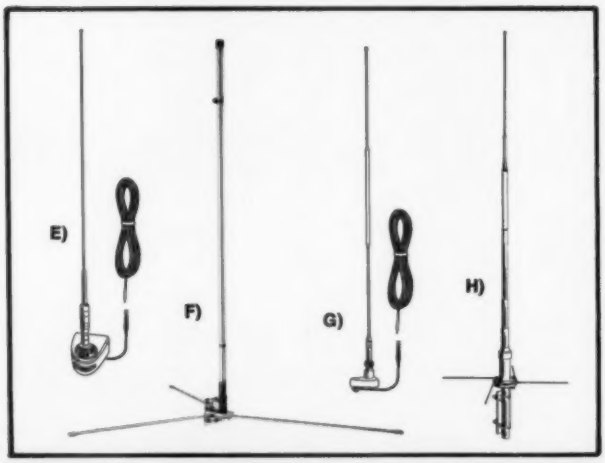

HW-202 Crystal Certificates

Crystals designed to exacting Heath standards assure optimum performance from your HW-202. A certificate will be sent to you postpaid. You mail the certificate to the manufacturer and get the crystals postpaid by return mail.

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New Heathkit HW-2026—the transceiver that gets you on 2 with synthesis for up to 50% less

This is the one you've been waiting for. State-of-the-art technology and exceptional operating ease...all in one easy-to-build kit that can save you hundreds of dollars. Compare and you'll agree.

True Digital Frequency Synthesizer. This is the way to go — no half-way schemes, no crystals to buy, no channel limitations. The HW-2026 uses digital technology with a voltage controlled oscillator (VCO) and 1 MHz crystal time base each of whose outputs are divided down to 5 kHz and compared in a phase detector. You control the divisor and therefore the frequency of the VCO from the front panel lever switches.

Lever-switched channel selection with digital readout. Just flip the levers on the front panel to select any frequency in any 2 MHz segment of the 144 to 147.995 operating range. You select the last four digits, three with the lever switches which display the frequency directly, and the last with the 0/5 kHz miniature toggle switch. The lever switches are easier to use than the usual thumbwheels and the 5 kHz steps make all 2-meter frequencies available to you. And if you inadvertently dial up an out-of-band frequency, don't worry — the transmitter won't key outside of the band.

LED status lights signal you that the synthesizer is "locked" on the frequency you dialed up and whether that channel is in use. Convenient.

Automatic repeater offset plus built-in tone encoder means you can work any open repeater. Use simplex or the −600 kHz offset, or add a crystal to the "Aux." position for offset. The encoder has both burst and continuous modes for access to most closed repeaters.

10 watts output & infinite VSWR without failure. That's a *minimum* of 10 watts out and it's circuitry-protected from high VSWR. (For more output, see the HA-202 amplifier below). True FM means great audio quality too.

A hot receiver with superior audio. 0.5 μV sensitivity...Schmitt-Trigger squelch with a threshold of 0.3 μV or less...diode protected dual gate MOSFETS in the front end...IC I.F....dual conversion... 8 pole crystal filter...linear audio response for a sound so natural you'll think the op. you're working is sitting in the room with you. Built-in, big 2" x 6" speaker plus jack for an external speaker.

One of the smallest synthesized rigs, yet easy to build with 5 circuit boards. Alignment requires only a VTVM...a freq. counter helps but alternate methods are described. Get the best value going in synthesized 2-M; get the new HW-2026.

Kit HW-2026, 12 lbs., mailable **289.95**

Kit HWA-202-1, AC supply, 7 lbs., mailable **32.95**

HW-2026 SPECIFICATIONS — RECEIVER — Sensitivity: .5 μV for 12 dB SINAD (or 15 dB of quieting). **Squelch Threshold:** .3 μV or less. **Audio Output:** 2 watts (typical) at less than 10% THD (5 kHz deviation). **Image Rejection:** Greater than 45 dB. **Spurious Rejection:** Greater than 50 dB. **IF Rejection:** Greater than 80 dB. **Internally Generated Spurious:** Below 1 μV equivalent, except at 146.87, 146.90, 147.46, 147.53, and 147.80 MHz. **Bandwidth:** 6 dB: 15 kHz, min. 60 dB: 30 kHz max. **Modulation Acceptance:** 7.5 kHz, minimum. **TRANSMITTER — Power Output:** 10 watts, minimum. **Spurious Output:** −40 dB within 2 MHz of carrier; −45 dB elsewhere. **Modulation:** FM, 0 to 7.5 kHz adjustable. **Duty Cycle:** 100% with ∞ VSWR. **Tone Encoder:** Burst mode: 1800 to 2500 Hz, 6 kHz deviation. Continuous Mode: 70 to 200 Hz, 0.7 kHz deviation. **GENERAL — Frequency Coverage:** 144.000 to 147.995 MHz (any 2 MHz segment). **Frequency Increments:** 5 kHz. **Frequency Stability:** ±.0015%. **Transmitter Offset:** 0 and −600 kHz supplied, provision for 1 additional. **Operating Temperature Range:** −10 to +50°C. **Current Consumption:** Receive: (squelched); 700 mA, max. Transmit: 2.5 A, max. **Operating Voltage:** 12.6 to 16.0 VDC, 13.8 VDC nominal. **Dimensions:** 2.75" H x 8.25" W x 9.875" D. **Weight:** 6 lbs.

A) Heathkit HW-202 2-Meter transceiver

Operates within spec. on any 2 MHz segment of the 143.9 to 148.3 MHz range; provides independent selection of 6 transmit and 6 receive channels. And all 12 crystals can be netted for optimum performance. The transmitter delivers a solid 10 watts minimum...more than enough to bring up most repeaters. Standard narrow band deviation adjustable up to 7.5 kHz with instant limiting.

Will operate into an infinite VSWR without failure. And the receiver is hot: 0.5 μV signal provides 15 dB of quieting...squelch threshold is 0.3 μV or less. Audio is excellent...output to the speaker is typically 2 watts at less than 3% harmonic distortion. Diode-protected dual gate MOSFETS in the front end...an IC IF that limits at less than 10 μV...dual conversion...a monolithic 4-pole 10.7 MHz crystal filter ...a built-in hash filter/voltage regulator keeps ignition noise out and maintains input voltage constant despite changing car system demand...complete built-in alignment procedures using the famous Heathkit manual and the front panel meter. Kit includes a set of crystals for 146.94 MHz to aid in tune-up and get you on the air in a hurry...push-to-talk mike...quick-connecting cable for 12 V hook-up ...heavy-duty alligator clips for use in a temporary installation... antenna coax jack...gimbal bracket...and a quick-release mobile mount so you can store the rig in the trunk when you leave the car. Get on 2 with maximum versatility and lowest cost with the HW-202. And check out the full line of accessories.

Kit HW-202, 11 lbs., mailable **179.95**

HW-202 SPECIFICATIONS — RECEIVER — Sensitivity: 12 dB SINAD* (or 15 dB of quieting) at .5 μV or less. **Squelch threshold:** 0.3 μV or less: **Audio output:** 3 W at less than 10% total harmonic distortion (THD). **Operating frequency stability:** Better than ±.0015%. **Image rejection:** Greater than 45 dB. **Spurious rejection:** Greater than 60 dB. **IF rejection:** Greater than 80 dB. **First IF frequency:** 10.7 MHz ±2 kHz. **Second IF frequency:** 455 kHz (adjustable). **Receiver bandwidth:** 22 kHz nominal. **De-emphasis:** −6 dB per octave from 300 to 3000 Hz nominal. **Modulation acceptance:** 7.5 kHz minimum. **TRANSMITTER — Power output:** 10 watts minimum. **Spurious output:** Below −45 dB from carrier. **Stability:** Better than ±.0015%. **Oscillator frequency:** 6 MHz, approximately. **Multiplier factor:** X 24. **Modulation:** Phase, adjustable 0-7.5 kHz, with instantaneous limiting. **Duty cycle:** 100%. **High VSWR shutdown:** None. **GENERAL — Speaker impedance:** 4 ohms. **Operating frequency range:** 143.9 to 148.3 MHz (will meet specifications ±1 MHz of alignment frequency within this range). **Current consumption:** Receiver (squelched): Less than 200 mA. Transmitter: Less than 2.2 amperes. **Operating temperature range:** −12° to 122° F (−25° to +50° C). **Operating voltage range:** 12.6 to 16.0 VDC (13.8 VDC nominal). **Dimensions:** 2¾" H x 8¼" W x 9⅞" D.

B) Tone Burst Encoder for HW-202

Components mount on a single circuit board and fits behind the HW-202's removable bezel. The four tone select buttons can be preset between 1800 Hz and 2500 Hz with bursts adjustable from 0.25 second to continuous. Frequency stability is ±1% from −30° to +50° C. Placing all buttons in out position removes encoder from circuit.

Kit HWA-202-2, 1 lb., mailable **26.95**

C) AC Power Supply for HW-202 or HW-2026

Delivers 13.8 VDC at 2.2A to your HW-202. Better than 1.0% regulation. 120/240 VAC wiring options, circuit breaker overload protection. With cables and 3-wire line cord.

Kit HWA-202-1, 7 lbs., mailable **32.95**

D) 40-watt 2-meter amplifier — NOW 59.95

Solid 40 W minimum for 10 W in. Draws only 7 A maximum from your car battery, and it can be mounted just about anywhere.

Fully automatic operation...an internal antenna changeover relay and sensing circuitry provide completely automatic T/R switching. Solid-state design features husky 2N5591 output devices in a highly efficient heat sink. Emitter-ballasted configuration enables the HA-202 to withstand VSWRs up to 3:1, yet remain cool and continue to run. Tuned input/output circuits provide low spurious radiation and allow coverage of any 1.5 MHz portion of the band. Final alignment requires only a VTVM, wattmeter or SWR bridge. Get your HA-202 today...and be working through the repeater tomorrow.

Kit HA-202, 4 lbs., mailable.....**Was 69.95 NOW 59.95**

HA-202 SPECIFICATIONS — Frequency range: 143-149 MHz. **Power output:** 20 W @ 5 W in. 30 W @ 7.5 W in, 40 W @ 10 W in, 50 W @ 15 W. in. **Power input (rf drive):** 5 to 15 W. **Input/output impedance:** 50 ohms, nominal. **Input VSWR:** 1.5:1 max. **Load VSWR:** 3:1 max. **Power supply requirements:** 12 to 16 VDC, 7 amps max. **Operating temperature range:** −30° F. to +140° F. **Dimensions:** 3" H x 4¼" W x 5½" D.

E) Standard gain mobile 2-M antenna

⅝-wavelength rear deck whip. 3.4 dB gain over ¼-wave vertical. Shunt fed matching maximizes radiation at point of lowest SWR; typically 1.1.1 at resonance. 100 watts power rating. 47" stainless steel radiator. 17' of RG-58-U coax with connectors.

Kit HWA-202-3, 2 lbs., mailable **19.95**

F) Standard gain fixed-station 2-M antenna

Mast mount ⅝-wave vertical with radials, 3.4 dB gain over ¼-wave ground plane; superior to conventional or end fed ½-wave antennas. 143-149 MHz, field adjustable. Enclosed matching transformer; 50 ohm impedance. SWR at resonance, 1.5:1 or better. 200 watts FM power rating. Hardware inc. for mounting to 1"-1⅜" mast. Coax not inc.

Kit HWA-202-4, 4 lbs., mailable **19.95**

G) Super gain mobile 2-M colinear antenna

Optimized low angle radiation by phasing of ¼ and ⅝ wave radiators. 5.2 dB gain over ¼ wave vertical. 180° swivel ball. 200 watt FM power rating. 6 MHz bandwidth; 1.5:1 or better SWR. Typical SWR at resonance, 1.1:1. Height: antenna & mount, 85". Removable stainless steel elements. 17' of RG-58-U coax with connectors.

Kit HWA-202-9, 3 lbs., mailable **37.95**

H) NEW Super gain fixed station 2-M colinear

6 dB gain over ¼ wave ground plane from two ⅝ wave colinear radiators with ¼ wave phasing. 140-150 MHz, field adjustable. 6 MHz bandwidth for 2:1 or better SWR. Resonance SWR, 1.2:1 at antenna. One kw FM power rating, for repeater, fixed station. Shunt fed with DC grounding. SO-239 connector. Alum. vertical element 117" long, 4 radials; 21" alum. rod. Wind load, 26 lbs. at 100 mph; wind survival, 100 mph. Mounts to 1¾" OD vertical pipe. Less coax.

Kit HWA-202-10, 8 lbs., mailable **47.95**

New 5-Band SSB Transceiver - The HW-104

Now the latest in broadband technology moves into the lower cost HW-series... the new HW-104 Transceiver... only 539.95

Concepts continued. In keeping with the tradition of the famous Heathkit HW-series of transceivers, the new HW-104 is the proud inheritor of the advanced technology pioneered by the SB-104 and the high value concept of the HW-101.

Completely solid-state...from receiver front end to transmitter out.

Totally broadbanded. Instant QSY. Just choose the band, frequency, and mode. Stays in tune anywhere, any band, without preselector, load, or tune controls.

Clean transmissions...100 watts out or 1 watt. Low harmonic and spurious radiation. At 100 watts, third order distortion is down 30 dB and carrier and unwanted sideband suppression are down 55 dB.

Clean, clear reception...thanks to the broadband design that minimizes cross-modulation and intermodulation. Active devices are minimized ahead of the 4-pole crystal filter. Adjacent signal overload is minimized and yet sensitivity is less than 1 μV. Convenient, too... with a 15 MHz WWV receive position on the band switch and a "pull-to-calibrate" position on the RF gain control.

Easy-to-read circular dial. Coverage from 3.5 MHz to 29.0 MHz. These are the two notable differences between the HW-104 and its parent SB-104. The dial spinner covers about 15 MHz per turn...smoothly. Built-in 100 kHz and 25 kHz calibrator insures the dial accuracy within 2 kHz (dial markings are 5 kHz). Backlash is 50 Hz or less. The VFO behind that dial is the same basic circuitry as the SB-104 with less than 100 Hz/hour drift after warmup. And if you need the top end of the 10 meter band, order the HWA-104-1 accessory for the necessary crystals and coils to get there (they all fit on circuit boards already in the chassis).

Easy to build and align. Nearly everything mounts on phenolic plug-in circuit boards and 2 wiring harnesses reduce much of the point-to-point wiring. An extender circuit board allows easy checking while operational. Because of broadband design, alignment is simple... all you need is a dummy load, a microphone, and a VTVM. When you've finished, it's ready to go mobile (for fixed station use, order the HP-1144 supply). Everything you need on a back panel is there and we even kept the lighted call sign on the "black out" front panel. Optional accessories include noise blanker, CW crystal filter, 10 meter option, speaker, and mobile mount. And you can use the SB-614 Station Monitor and SB-634 Station Console with your HW-104.

An experience in operating...a lesson in value. Both are super and you get both in the new HW-104.

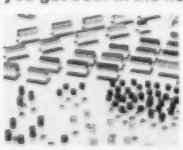
Kit HW-104, 31 lbs., mailable **539.95**
Kit HP-1144, AC power supply, 28 lbs., mailable **89.95**
Kit HS-1661, station speaker, 5 lbs., mailable **19.95**
Kit HWA-104-1, ten-meter accessory, 1 lb., mailable **16.95**
SBA-104-1, noise blanker, 1 lb., mailable **26.95**
SBA-104-2, mobile mount, 6 lbs., mailable **36.95**
SBA-104-3, 400 Hz CW crystal filter, 1 lb., mailable **39.95**

HW-104 SPECIFICATIONS — GENERAL — Active Devices: All solid-state. **Frequency Coverage:** 3.5 MHz through 29.0 MHz amateur bands, (through 29.7 MHz, with HWA-104-1 accessories) WWV receive only) on 15 MHz. **Frequency Stability:** Less than 100 Hz/hour drift after 30-min. warmup; less than 100 Hz drift for ±10% change in primary voltage. **Modes of Operation:** Selectable upper or lower sideband (suppressed carrier) and CW. **Dial Accuracy:** Within 2 kHz after calibration at nearest 100 kHz marker. Built-in calibrator provides 100 kHz and 25 kHz markers. 5 kHz dial markings. **Tuning Rate:** Approximately 15 kHz per turn. **Audio Frequency Response:** 350 to 2450 Hz ±75 Hz (6 dB bandwidth). **Tuning Backlash:** 50 Hz or less. **Phone Patch Impedance:** 4Ω output to speaker; high impedance output to transmitter. **Power Requirements:** 13.8 VDC nominal (maximum 16 VDC) at: Receive: 2 amps. Transmit, low power: 3 amps. Transmit, high power: 20 amps. **TRANSMITTER — RF Power Output: High Power** (50Ω nonreactive load). SSB: 100 watts PEP ±1 dB, CW: 100 watts ±1 dB. **Low Power:** SSB: 1 watt PEP (minimum), CW: 1 watt (minimum). **Output Impedance:** 50 ohms, less than 2:1 SWR. **Carrier Suppression:** 55 dB down from 100 watt single-tone output at 1000 Hz reference. **Harmonic Radiation:** 45 dB below 100 watt output. **Spurious Radiation:** —50 dB within ±3 MHz of carrier, except, on the 3.5 band, —40 at 3.395 MHz. —60 dB greater than ±3 MHz from carrier. **Third Order Distortion:** 30 dB down from two-tone output, reference at 100 watts PEP. **Transmit/Receive Operation:** SSB: PTT or Vox. CW: Keyed-tone Vox or Manual. **NOTE:** In the low power mode all transmit-receive switching is solid-state. **CW Sidetone:** Internally switched to speaker or headphones in CW mode. Approximately 700 Hz tone. **Microphone Input:** High impedance with a rating of —45 to —55 dB; approximately 25 kΩ to match Heath desk-type microphone. **RECEIVER — Sensitivity:** Less than 1 microvolt for 10 dB signal-plus-noise-to-noise for SSB operation. **Selectivity:** 2.1 kHz minimum at 6 dB down, 7 kHz maximum at 60 dB down. **CW Selectivity (with accessory CW filter):** 400 Hz at 6 dB down, 2 kHz at 60 dB down. **Overall Gain:** Less than 1 microvolt for 0.5 watt audio output. **Audio Output:** 2.5 watts into 4 ohms, 1.25 watts into 8 ohms, at less than 10% THD. Low impedance headphones (4-8 ohm). **AGC:** Less than 1 millisecond attack time; switch selectable 100 μsec and 1 S release, and OFF. **Intermodulation Distortion:** —60 dB. **Image Rejection:** —60 dB. **IF Rejection:** —60 dB. **Internally Generated Spurious Signals:** Below 2 microvolt equivalent antenna input, except at 3.65, 3.74, 14.25, and 21.2 MHz. **MECHANICAL — Front Panel Controls/Switches:** AGC — Off, Slow, Fast; AF Gain; Microphone Jack; Headphone Jack; Main Tuning; Mic/CW Level; Vox Gain; Vox Delay; Bandswitch; RF Gain/Calibrator On-Off. **Pushbuttons;** ALC (Meter); 13.8V (Meter); Relative Power (Meter); Vox (On/Off); 25/100 kHz Calibrate Select; Noise Blanker (On/Off); LSB (Mode); USB (Mode); CW (Mode); Tune; Hi/Lo (Power Select); **PWR** (On/Off). **Rear Panel Controls/Sockets:** Anti-Trip; Sidetone Level; Linear Amplifier ALC Input; Phone Patch Input; Phone Patch Output; Key (CW) Input; Speaker (4 ohm) Output; Spare (2); Receiver Audio Input; VFO Input; VFO Output; IF Output; Driver Output; Ground Post; Power Plug; Accessory Socket (includes relay output); Antenna Input; Receiver Antenna Input; Common/Separate Antenna Switch. **Cabinet Dimensions:** (less knobs, feet, sockets, rails) 5¾" H x 14⅜" W x 13⅞" D (14.6 cm. x 36.75 cm. x 35.24 cm.). **Net Weight:** 20 lbs. (7 kg.)

HS-1661 Station Speaker. Styled to match the HW-104; response tailored to SSB. Cable and plug are included.

Kit HS-1661, 5 lbs., mailable **19.95**

HS-1661 SPECIFICATIONS — Speaker Size: 5" x 7" oval. **Voice Coil Impedance:** 3.2 ohms. **Frequency Response:** 300 to 3000 Hz. **Magnet Weight:** 3.16 oz. **Cabinet:** Aluminum with green wrinkle finish. **Dimensions:** 5⅜" H x 8¾" W x 5⅝" D.

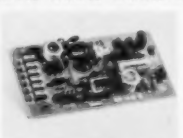


All solid-state...including the finals. **Output warranted for one year.**

Completely broadbanded. No tuning from 3 to 30 MHz...instant QSY.

Built-in 100 kHz & 25 kHz calibrator. Keeps your dial scale accurate to 2 kHz.

Circuit board construction seven major boards can be extended for adjustment.



Optional noise blanker for up to 50 dB of effective blanking.

Complete back-panel connections: Access in & out to everything needed.

Heathkit performance specifications are guaranteed

Go CW for More Fun and Challenge

New Solid State Electronic Keyer...49.95

Sending code's easy with the HD-1410 whether you're operating base or portable. The dot and dash paddles travel and tension are easily adjustable. When the two paddles are treated as one, the HD-1410 operates like a single-paddle keyer with dot and dash memories. Iambic operation forms most characters with reduced wrist movement. Dots and dashes are self-completing and always in proper proportion. During construction, you select the speed range you want—10 to 35 words per minute or 10 to 60 words per minute. Operates on 120 VAC or 12 VDC. Adjustable sidetone frequency, built-in speaker, headphone jack. Styled to match our famous "SB" line.

Kit HD-1410, 5 lbs., mailable **49.95**

HD-1410 SPECIFICATIONS — Keying Speed: Variable from under 10 to over 35 or from under 10 to over 60 wpm. **Keying Output, Positive Line to Ground:** max. voltage open circuit or spikes — 300 volts. Max. current — 200 mA. **Keying Output, Negative Line to Ground:** max. voltage open circuit or spikes — 200 volts. Max. current — 10 mA. **Audio:** internal speaker or jack for optional hi-Z (at least 500 ohms) headphones. **Sidetone:** adjustable from 500 to 1000 Hz. **Internal Controls:** sidetone frequency, paddle tension, paddle travel. **Rear Panel Connections:** AC power cord, 12-volt power input, keyer out, headphones, receiver audio in, ext. key. **Temperature Range:** 0°C to +40°C (typ. −10°C to +40°C) or approx. 50°F to 105°F. **Power Requirement:** 120/240 VAC (±10%), 60/50 Hz, 3.5 watts or 10-14.5 VDC, negative ground, 150 mA. **Dimensions:** approx. 3" H x 5" W x 7½" D. **Net Weight:** 3 lbs.

B)

C)

A) The famous Heathkit 3-band QRP CW Transceiver...89.95

Work the world on one or two watts. That's the challenge of QRP... and the HW-7 is ready to help you meet it. And whether you're an avid QRPer, an experienced OM looking for a portable emergency/vacation rig, you'll appreciate the Heathkit HW-7. The all solid-state circuitry features both built-in high stability VFO and crystal-controlled transmit capability. Direct conversion receiver circuitry delivers solid-copy with as little as 1 microvolt input. The transmitter has 3 watts input on 40 meters...2½ watts on 20 meters...and 2 watts on 15. Band-changing and tune-up are quick and simple: pushbutton band-selection...large main tuning dial with 6 to 1 vernier drive that's virtually backlash-free...receiver preselector marked for 40, 20 and 15 M bands...single-knob final tuning. Pushbutton crystal transmit provision is ideal for roundtables and nets.

Top-value features include: built-in sidetone...front panel relative power meter...break-in keying with adjustable T/R delay...headphone jack...small size and light weight. The HW-7 can be operated from the accessory AC power supply, an equivalent low impedance supply, or 12 VDC lantern or auto batteries...draws only 35 mA on receive, 450 mA on transmit. Assembly is easy, quick (about 3 evenings) and fun. All circuitry mounts on a single circuit board. Get an excellent QRP rig...and a portable rig...and a low cost Novice rig ...get your HW-7 now.

Kit HW-7, Transceiver, less batteries, 6 lbs., mailable **89.95**

Kit HWA-7-1, low voltage power supply provides 13 VDC to power the HW-7 Transceiver from an AC power source. 120/240 VAC operation. 4 lbs., mailable **14.95**

HW-7 SPECIFICATIONS — TRANSMITTER: RF Power Input: 3 watts on 40 meters, 2.5 watts on 20 meters. 2 watts on 15 meters. **Frequency Control:** 40 meter crystal, or built-in VFO on 40 meters. 20 meter crystal or built-in VFO on 20 meters. 15 meter crystal, or built-in VFO on 15 meters. **Output Impedance:** 50 Ω unbalanced. **Sidetone:** Built-in. **Spurious and Harmonic Levels:** At least 25 dB down. **RECEIVER: Sensitivity:** Less than 1 microvolt provides a readable signal. **Selectivity:** 1 kHz at 6 dB down. **Type of Reception:** CW. **Audio Output Impedance:** 1000 Ω nominal. **GENERAL: Frequency Coverage:** 40 meters 7.0 to 7.2 MHz. 20 meters, 14.0 to 14.2 MHz. 15 meters, 21.0 to 21.3 MHz. **Frequency Stability:** Less than 100 Hz drift after 10 minutes warmup. **Power Required:** 13 volts DC, 35 mA receive and 450 mA transmit. **Dimensions:** 4¼" H x 9¼" W x 8½" D, including knobs and feet.

B) One of the world's most popular CW rigs... the Heathkit HW-16...129.95

We've sold thousands of these fine rigs... it's a rare ham that hasn't at least operated the HW-16. Why so popular? The features speak for themselves: optimum CW operation on the first 250 kHz of the 80, 40 and 15 meter bands...true break-in capability with solid-state T/R switching...75 watt input for Novices, up to 90 watts for General and above...crystal-controlled transmit with VFO receive... provision for VFO transmit with Heathkit HG-10B VFO...500 Hz CW selectivity with high quality crystal filter...receiver sensitivity better than 1 microvolt...built-in sidetone...front panel Rel Pwr/Plate Current meter...easy, enjoyable assembly with the famous Heathkit manual...final assembly and checkout requires only a VTVM, dummy load, key and appropriate crystals.

Kit HW-16, 25 lbs., mailable **129.95**

HW-16 SPECIFICATIONS—TRANSMITTER SECTION: RF power input: 50-90 W (adjustable). **Frequency control:** 80 meter crystal or VFO on 80-meter band. 80- or 40-meter crystal, or VFO on 40-meter band. 40-meter crystal or VFO on 15-meter band. **Keying:** Grid-block. Break-in with automatic antenna switching and receiver muting. **Output impedance:** 50 ohm unbalanced. SWR less than 2:1. **Sidetone:** Neon lamp relaxation oscillator. **RECEIVER SECTION: Sensitivity:** Less than 1 μV for 10 dB S+N/N. **Selectivity:** 500 Hz at 6 dB down. **Intermediate frequency:** 3396 kHz. **Antenna impedance:** 50 ohm, unbalanced. **External speaker impedance:** 8 ohm. **GENERAL: Frequency coverage:** 3.5 to 3.75 MHz. 7.0 to 7.25 MHz. 21.0 to 21.25 MHz. **Power:** 120 VAC, 50-60 Hz. **Dimensions:** 6½" H x 13¾" W x 11½" D.

C) Code Practice Oscillator...9.95

As much fun to build as it is to use—and it makes a great starter kit for a beginning CW operator. The molded plastic cabinet with dark green front panel matches Heathkit "SB" series gear.

Safe, portable and reliable, the HD-1416 is designed in the Heath tradition of top quality and value. Most components mount on a single circuit board for easy assembly. The unit operates from a single inexpensive 9-volt transistor battery (not supplied) and comes complete with telegraph key and phone jack. The oscillator, with built-in speaker, has a separate control for volume on the front panel—as well as a tone control accessible from the back of the cabinet. The HD-1416 can also be used as a side tone oscillator with any transmitter using grid block keying—such as the Heathkit DX-60B.

Kit HD-1416, 2 lbs., mailable **9.95**

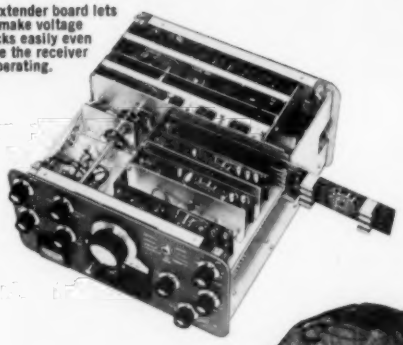
HD-1416 SPECIFICATIONS — Mode of Operation: Speaker or headphones. **Tone Frequency:** 200-800 Hz adjustable. **Battery Required:** 9-volt transistor battery equivalent Neda #1604 (not supplied). **Speaker:** 45 ohms. **Headphones:** 8-2000 ohms. **Sidetone Oscillator:** Grid block keying transmitters (400 volts DC, negative maximum). **Controls:** Volume, Tone (internal). **Front Panel Connections:** Key, Phone jack. **Transistors:** (2) MPSA20, (1) 2N5249. **Color:** Wrinkle grey and dark green.

Heathkit SB-

A)

B)

An extender board lets you make voltage checks easily even while the receiver is operating.



C)

Start your own ham shack library with these outstanding book values:

Single-Sideband: Theory and Practice — a one-source guide emphasizing basic principles & circuitry rather than math. **EDP-120,** **6.95***

Radio Handbook — the standard work on practical & theoretical aspects of radio communications and electronics. **EDP-117,** **16.95***

*$10 minimum order for book **only** purchase. No minimum when book order accompanies kit order. Include 35¢ for each book to cover postage and handling.

D)

E)

Heathkit products are the result of a quarter-century of kit engineering experience

world famous performance & value

A) SB-401 SB Transmitter...389.95

Thousands of hams the world over are using this renowned series of transmitters for a lot of reasons, but one stands out above all...its performance/value ratio. Stable, convenient, powerful...at a reasonable price.

180 watts PEP, USB or LSB, 170 watts CW input, from 3.5 to 30 MHz, with a crystal controlled heterodyne oscillator and preassembled and aligned linear master oscillator for accuracy and stability you can count on. Versatile, too...use it in "transceive" with any Heathkit SB-300 series receiver, or with any other by adding the SBA-401-1 Crystal Accessory. Other features include: voice operated (VOX) and push-to-talk (PTT) control in SSB mode; break-in keying in CW mode; built-in antenna change-over relay, switched 120 VAC for an external antenna relay, crystal filter type SSB generator, automatic level control for low distortion, high talk power. The large circular dial has calibrations every kHz and covers 100 kHz per revolution for a bandspread equal to about 10 feet per megahertz; the slide-rule dial pointer indicates the number of rotations of the circular dial. The 5-function meter indicates grid current, plate current, ALC action, plate voltage, and relative power output. Dual voltage primary, transformer operated, silicon-diode power supply for long life and low heat power. Build it ...enjoy it.

Kit SB-401, 36 lbs., mailable **389.95**

SBA-401-1, Crystal pack, 1 lb., mailable **29.95**

SB-401 SPECIFICATIONS — Emission: SSB (upper or lower sideband) and CW. **Power input:** 170 W CW, 180 W P.E.P. **Power output:** 100 W (80-15 meters), 80 W (10) meters. **Output impedance:** 50-75 ohm — less than 2:1 SWR. **Frequency range:** 80-10 M amateur bands. **Frequency stability:** <100 Hz/hr. drift after 20 min. warmup. **Carrier suppression:** 55 dB below peak output. **Unwanted sideband suppression:** 55 dB @ 1 kHz. **Intermodulation distortion:** 30 dB below peak output (two-tone test). **Keying characteristics:** Break-in CW provided by operating VOX from a keyed tone (Grid block keying). **CW sidetone:** 1000 Hz. **ALC characteristics:** >10 dB @ 0.2 mA final grid current. **Noise level:** 40 dB below rated carrier. **Visual dial accuracy:** Within 200 Hz (all bands). **Backlash:** <50 Hz. **Oscillator feedthrough or mixer products:** 55 dB below rated output (except 3910 kHz crossover which is 45 dB). **Harmonic radiation:** 35 dB below rated output. **Audio input:** High impedance microphone or phone patch. **Audio frequency response:** 350-2450 Hz ±3 dB. **Power requirements:** 80 W Stby, 260 W key down @ 120/240 VAC, 50/60 Hz. **Dimensions:** 6⅛" H x 14⅞" W x 13⅜" D.

B) SB-303 Receiver...389.95

80 through 10, SSB, CW, RTTY, and AM...the world over...all at your fingertips in this solid-state wonder of stability, selectivity, and sensitivity. The preassembled, prealigned solid-state LMO and crystal controlled heterodyne oscillators assure stable and linear tuning with a calibrated dial readout in 1 kHz increments and 100 Hz stability. Calibrate it with its built-in dual frequency integrated circuit crystal calibrator with markers for every 100 kHz or 25 kHz...or tune to WWV at 15 MHz. It has a 0.25 microvolt sensitivity and 2.1 kHz SSB selectivity to keep you going even when the band isn't, and an RF attenuator to use when it is. Three-position AGC, too, to make SSB operating easier.

Solid-state circuitry has 28 silicon transistors including 4 MOSFETS and an IC plus a transistor-regulated dual-primary power supply to control oscillators under varying line voltages and load conditions. Power and antenna connections for two VHF convertors and four spare sockets for adding Heathkit station accessories.

Easier-than-ever assembly with modular plug-in Switch-Boards and circuit boards, plus extender boards for easier adjustment...all you need for alignment is an 11-megohm VTVM.

Kit SB-303, 22 lbs., mailable **389.95**

SBA-301-1, Optional 3.75 kHz AM crystal filter, 1 lb., mailable **24.95**

SBA-301-2, Optional 400 Hz CW crystal filter, 1 lb., mailable **29.95**

SB-303 SPECIFICATIONS — Frequency range: 18-10 M amateur bands; 15 MHz WWV. **Intermediate frequency (IF):** 3.395 MHz. **Frequency stability:** <100 Hz drift/hr. after 10 min. warmup <100 Hz drift for ±10% line voltage variation. **Modes of operation:** SSB, CW, AM, RTTY. **Sensitivity:** <0.25 μV for 10 dB S+N/N for SSB operation. **Overall gain:** <1.5 μV input for 0.5 W audio output (single tone SSB). **AGC Characteristics:** Blocking — >3.0 V CW/SSB/RTTY. Dynamic Range — >150 dB CW/SSB. RF Attenuator — variable 0.40 dB nominal. **Selectivity:** SSB — 2.1 kHz @ 6 dB down, 5.0 kHz max. @ 60 dB down (crystal filter supplied). CW — 400 Hz @ 6 dB down, 2.0 kHz max. @ 60 dB down (accessory CW crystal filter). AM — 3.75 kHz @ 6 dB down, 10 kHz max. @ 60 dB down (accessory AM crystal filter). RTTY — 2.1 kHz @ 6 dB down, 5.0 kHz max. @ 60 dB down (uses SSB crystal filter). **Image rejection:** >60 dB. **IF rejection:** 3.395 — >55 dB. 8.595 — >50 dB. **Spurious response:** All below 1 μV equivalent signal input. **Temperature ranges:** 10°C-50°C ambient. **Dial accuracy:** Electrical — Within 400 Hz after calibration at nearest 100 kHz or 25 kHz point. Visual — Within 200 Hz. **Calibration:** Every 100 kHz or 25 kHz. **Dial Accuracy:** No more than 50 Hz. **Antenna Input Impedance:** 50 ohm nominal unbalanced. **Audio response:** SSB — 350-2420 Hz nominal @ 6 dB. CW (with accessory filter) — 800-1200 Hz nominal @ 6 dB. **AM** (with accessory filter) — 200-3500 Hz nominal @ 6 dB. RTTY — 1840-3940 Hz nominal @ 6 dB. **Audio output impedance:** Speaker — 8 ohm; Headphones — Low impedance. **Audio Output Power:** 4 W < 10% distortion. **Muting:** Open external ground at mute socket. **Power Requirements:** 120/240 VAC, 40 W max. **Cabinet Dimensions:** 6⅝" H x 12¼" W x 13" D. **Overall Dimensions** (with knobs & feet installed): 7¾" H x 12¼" W x 14" D.

C) You can't beat the price on this 5-band transceiver...the famous HW-101..299.95

One of the world's best transceiver values. If you've shopped the amateur radio world for transceivers, we think you'll agree the HW-101 is tough to beat in price...or performance. Even its accessories cost less. Compare and be convinced.

Hybrid design, full featured. 20 tubes and 19 semiconductors are combined with the operating features you need. 180 watts input PEP, 170 watts input CW; 0.35 μV sensitivity; FET VFO; PTT and VOX with anti-trip; triple action level control; smooth dial drive with 36-to-1 ratio; built-in 100 kHz calibrator; 4-function meter for receive, ALC on transmit, relative power output, or final cathode current; all going for you on USB, LSB, or CW on 80 through 10.

Easy to build. Circuit boards, wiring harness, and "Switch-Boards" make it happen fast and easy. Build it...join the thousands of hams who've found you can't beat it.

Kit HW-101, 23 lbs., mailable **299.95**

SBA-301-2, 400 Hz CW crystal filter, 1 lb., mailable **29.95**

HW-101 SPECIFICATIONS — RECEIVER: Sensitivity: <0.35 μV for 10 dB S+N/N for SSB operation. **SSB selectivity:** 2.1 kHz min. @ 6 dB down; 7 kHz max. @ 60 dB down (3.395 MHz filter). **CW selectivity:** (optional SBA-301-2 CW crystal filter); 400 Hz min. @ 6 dB down; 2.0 kHz max. @ 60 dB down. **Input:** Low impedance for unbalanced coaxial input. **Output impedance:** 8 ohm speaker, and high impedance headphone. **Power output:** 2 watts with <10% distortion. **Spurious response:** Image and IF rejection >50 dB. **TRANSMITTER: DC power input:** SSB 180 watt PEP (normal voice, continuous duty cycle). CW 170 watts (50% duty cycle). **RF power output:** 100 watts on 80 through 15 meters; 80 watts on 10 meters (50 ohm non-reactive load). **Output impedance:** 50 ohm to 75 ohm with <2:1 SWR. **Oscillator feed-through or mixer products:** 55 dB below rated output. **Harmonic radiation:** 45 dB below rated output. **Transmit-receive operation:** SSB: PTT or VOX. CW: Provided by operating VOX from a keyed tone, using grid-block keying. **CW sidetone:** Internally switched to speaker or headphone in CW mode. Approx. 1000 Hz tone. **Microphone input:** High impedance with a rating of −45 to −55 dB. **Carrier suppression:** 45 dB down from single-tone output. **Unwanted sideband suppression:** 45 dB down from single-tone output at 1000 Hz reference. **Third order distortion:** 30 dB from two-tone output. **RF compression (TALC*):** >10 dB at .1 mA final grid current. **GENERAL: Frequency coverage:** 80-10 M amateur bands. **Frequency stability:** <100 hertz per hour drift after 45 minutes warmup from normal ambient conditions. <100 Hz for ±10% line voltage variations. **Modes of operation:** Selectable upper or lower sideband (suppressed carrier) and CW. **Dial calibration:** 5 kHz. **Calibration:** 100 kHz crystal. **Audio frequency response:** 350 to 2450 Hz. **Power requirements:** 700 to 850 volts at 250 mA with .1% maximum ripple; 300 volts at 150 mA with .05% maximum ripple; −115 volts at 10 mA with .5% maximum ripple; 12 volts AC/DC at 4.76 amps. (see fixed & mobile power supplies below). **Cabinet dimensions:** 6¾" H x 14¼" W x 13⅜" D.

*Triple Action Level Control.

D) Get your station on the road with an HP-13B Mobile Power Supply...84.95

The solid-state circuit has been further refined for improved starting and power transistor protection. The bias voltage is now fixed and we've put heavier wires in the filament leads of the power cable.

Kit HP-13B, DC power supply, 8 lbs., mailable **84.95**

HP-13B SPECIFICATIONS — Input voltage: 12 to 16 VDC (neg. ground only). **Input current:** 25 amp. max. full load. **High voltage output:** 800 VDC, no load; 750 volts DC @ 250 mA. AC ripple: less than 1% @ 250 mA. Duty cycle: Continuous up to 150 mA; 50% up to 300 mA. **Low voltage output:** (high tap) 310 VDC, no load; 200 VDC @ 150 mA. (low tap) 265 VDC, no load; 250 VDC @ 150 mA. AC ripple: Less than .05% @ 150 mA. Continuous duty cycle to 175 mA. **Fixed bias:** −130 VDC @ 20 mA. **Switching frequency:** 1500 Hz (approx.). **Ambient temperature:** −10° to 122°F. **Dimensions:** 7¾" W x 7⅛" L x 2⅜" D. All voltages referenced at 13 VDC.

E) Heathkit HP-23B Fixed-Station Power Supply...just 57.95

Our popular fixed station power supply now features a higher voltage rating on B + filter capacitors; improved filtering on bias voltage; fixed bias voltage, and heavier filament wires in the power cable. Now the popular Heathkit power supply is better than ever.

Kit HP-23B, AC power supply, 19 lbs., mailable ...**57.95**

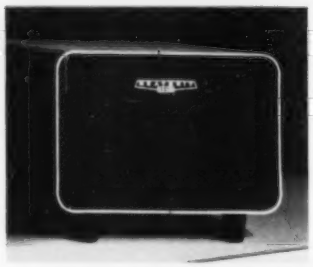
HP-23B SPECIFICATIONS — Power requirements: 120/240 VAC, 50-60 Hz, 350 watts maximum. **High voltage output:** 820 VDC no load; 700 VDC @ 250 mA ±10%. AC ripple: Less than 1% @ 250 mA. Duty cycle: 150 mA continuous to 300 mA @ 50%. **Low voltage output:** (High tap) 350 VDC, no load; 300 VDC @ 150 mA ±10%, (Low tap) 275 VDC, no load, 250 VDC @ 100 mA, ±10%. Less than .05% AC ripple @ 150 mA, continuous duty to 175 mA. **Fixed bias:** −130 VDC ±10%, no load; −100 VDC @ 20 mA. **Filament voltage:** 12.6 VDC @ 5.5 amps. **Dimensions:** 9" L x 4¾" W x 6¾" H.

Heathkit station accessories

A)

B)

C)



Add these to your original SB transceivers and separates now.

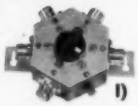
D)

E)

F)

G)

H)

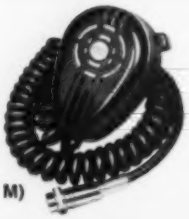


I)

J)

K)

L)



M)

N)

U.S. Callbook
EDP-126, ... **12.95***

DX Callbook
EDP-127, ... **11.95***

Amateur Tests and Measurements – tells in simple language how to make all necessary performance tests & adjustments on transmitters, receivers & antennas.
EDP-119, ... **5.50***

73 Dipole and Long-Wire Antennas – includes dimensions, configurations, construction & measurements data for 73 different antennas.
EDP-180, ... **4.95***

73 Vertical, Beam and Triangle Antennas – contains construction, design & measurement data on practically all types of antennas used by amateurs.
EDP-181, ... **4.95***

ARRL Antenna Handbook
EDP-182, ... **3.00**

Heathkit products are the result of a quarter-century of kit engineering experience

A) Heathkit 1 kW Amplifier...299.95

Probably the most popular linear on the market...and no wonder. Delivers a full 1200 W PEP SSB input...1 kW on CW.

Kit SB-200, 50 lbs., mailable **299.95**

SB-200 SPECIFICATIONS — Band coverage: 80, 40, 20, 15 & 10 meters. **Maximum power input:** 1200 W P.E.P. SSB, 1000 W CW. **Driving power required:** 100 W. **Duty cycle:** SSB, continuous voice modulation; CW 50% (key down time not to exceed 5 min.). **Third order distortion:** 30 dB or better at 1000 W P.E.P. **Output impedance:** 50-75 ohm unbalanced; variable pi-output circuit. **SWR:** not to exceed 2:1. **Input impedance:** 52 ohm unbalanced; broadband pretuned input circuit requires no tuning. **Meter functions:** 0-100 mA grid current, 0-100 mA plate current, 0-1000 mA plate current, 0,1000 relative power, 1:1-3:1 SWR, 1500-3000 volts high voltage. **Front panel controls:** Load; Tune; Band; Relative Power Sensitivity; Meter Switch, Grid-Plate-Rel. Power-SWR-HV; and Power Switch, on/off. **Tube complement:** Two 572B/T-160-L (in parallel). **Power requirements:** 120 VAC @ 16 A (max.), 240 VAC @ 8 A (max.). **Cabinet size:** 6⅝" H x 14⅞" W x 13⅜" D.

B) Heathkit 2 kW Amplifier...449.95

This is the one that made history when we announced it...and it's easy to understand why. A pair of Eimac 3-500Zs in grounded grid deliver up to 2 kW PEP SSB input...a full 1 kW on CW and RTTY. Requires just 100 W drive for full output. Pretuned broadband pi-input provides maximum efficiency and minimum distortion from 80 — 10 meters. Features include a husky built-in solid-state supply that can be wired for either 120 or 240 VAC...built-in circuit breaker protection...Zener diode regulated operating bias to reduce idle I_p for cool running, longer tube life...fan cooled, well-shielded final compartment...complete metering facilities. Another example of what happens when ham products are designed by hams...the Hams at Heath. Get your 220 today.

Kit SB-220, 70 lbs., mailable **449.95**

SB-220 SPECIFICATIONS — Band coverage: 80, 40, 20, 15 and 10 meters. **Driving power:** 100 W. **Max. power input:** SSB, 2000 W, P.E.P.; CW, 1000 W.; RTTY, 1000 W. **Duty cycle:** SSB, Continuous voice modulation. CW, Continuous (maximum key-down 10 minutes). RTTY, 50% (maximum transit time 10 minutes). **Third order distortion:** —30 dB or better. **Input impedance:** 52 ohm unbalanced. **Output impedance:** 50 ohm unbalanced; SWR 2:1 or less. **Front panel controls:** Tune, Load, Band, Sensitivity Meter Switch, Power CW/Tune — SSB, Plate meter, Multi-meter (Grid mA, Relative Power and High Voltage). **Rear panel:** Line cord, circuit breakers (two 10 A). Antenna Relay (phono). ALC (phono). RF Input (SO 239). Ground post. RF Output (SO-239). **Tubes:** Two Eimac 3-500Z. **Power required:** 120 VAC, 50/60 Hz at 20 amp. max. 240 VAC, 50/60 Hz at 10 amp. max. **Cabinet size:** 8¼" H x 14⅞" W x 14½" D.

C) Heathkit Station Speaker...22.95

Audio response is shaped from 300-3000 Hz for optimum sideband reproduction. Eight ohm Z matches most gear. Large 6½" H x 10" W x 10½" D cabinet provides mounting space for any HP-23 series supply. Gray and green styling matches the SB line.

Kit SB-600, 7 lbs., mailable **22.95**

D) Heathkit Spectrum Analyzer...149.95

Provides 10 and 50 kHz sweep widths for single signal analysis... variable sweep to 100 kHz for 455 kHz IFs to 500 kHz above 1 MHz. Both log and linear displays. Operates with common receiver IFs up to 5.2 MHz. Gray and green styling to match other SB-series gear... 6⅝" H x 10" W x 10½" D. Not for use with SB-104.

Kit SB-620, 15 lbs., mailable **149.95**

E) Heathkit solid-state Dip Meter—more performance at big savings...59.95

Another Heath value triumph — a better dip meter at lower cost. The Colpitts oscillator covers 1.6 to 250 MHz in fundamentals with a MOS-FET paraphase amplifier and hot-carrier diodes for more sensitivity and a better dip. It uses a Q-multiplier for greater detector sensitivity and a responsive 150 μA meter movement for positive resonance indications. It includes a phone jack for modulation monitoring. It's smaller and lighter than others. And it's a whole lot less expensive.

Completely portable. Whether you're checking resonant frequencies, adjusting traps, looking for parasitics, or using it as a signal generator, the HD-1250 is designed to go anywhere. It fits your hand and thanks to its solid-state design and 9-volt battery operation, it's ready to use instantly wherever you are. The custom molded gray carrying case protects the meter and the 7 color-coded, pre-adjusted, plug-in coils in transit, and makes a handy storage place.

Build it in one evening. Nearly everything mounts on two circuit boards. And when you finish, you'll have the best dip meter around — for a lot less money.

Kit HD-1250, less battery, 4 lbs., mailable **59.95**

F) Heathkit RF Load/Wattmeter...59.95

Every ham should have a dummy load and a wattmeter in the shack, and now you have both in a single piece of gear. A husky 50 ohm non-inductive load resistor handles 175 W continuous, 1 kW intermittent...less than 1.2:1 SWR from 1.8 to 30 MHz. High-temp lamp & lamp test circuit. Meter ranges of 0-200 & 0-1000 W, ±10% FS accuracy.

Kit HM-2103, 6 lbs., mailable **59.95**

HM-2103 SPECIFICATIONS — Frequency Range: 1.8 to 30 MHz. **Wattmeter Range:** 0-200 and 0-1000. **Wattmeter Accuracy:** ±10% of full-scale reading. **Power Rating:** 175 watts continuous, 1000 watts maximum. **Overload Indication:** Thermal switch activated (requires 9 volt battery, NEDA #1604). **SWR:** Less than 1.2:1. **Load Type:** Noninductive. **Load Impedance:** 50 ohms nominal. **Connectors:** UHF type SO-239. **Dimensions:** 6" H x 5⅜" W x 13¾" D.

G) Heathkit VHF Wattmeter...34.95

A VHF wattmeter at this low price? Well, that's what happens when your engineering department is populated with VHF fans. Power ranges of 1-25 & 10-250 W FS ±10%. 50 ohm nominal Z for minimum loss. Built-in SWR bridge with adjustable sensitivity.

Kit HM-2102, 4 lbs., mailable **34.95**

HM-2102 SPECIFICATIONS — Frequency range: 50 MHz to 160 MHz. **Wattmeter accuracy:** ±10% of full-scale.* **Power capability:** To 250 W. **SWR sensitivity:** Less than 10 W. **Impedance:** 50 ohms nominal. **SWR bridge:** Continuous to 250. **Connectors:** UHF type SO-239. **Dimensions:** 5¼" W, 5¼" H and 6½" D, assembled as one unit.
*Using a 50 Ω noninductive load.

H) Heathkit Wattmeter/SWR Bridge...34.95

Two switch-selected ranges: 10-200 & 100-2000 W...built-in SWR bridge with adjustable sensitivity...negligible insertion loss in 50 ohm line. Remote detector permits placement of meter in any convenient location...6 ft. of cable supplied.

Kit HM-102, 4 lbs., mailable **34.95**

HM-102 SPECIFICATIONS — Frequency range: 1.8 to 30 MHz. **Wattmeter accuracy:** ±10% of full-scale reading. **Power capability:** 10 to 2000 watts. **Impedance:** 50 ohm nominal. **Connectors:** UHF type SO-239. **Dimensions:** 5$^{15}/_{16}$" H x 2¼" W x 6½" D.

I) Heathkit Coax Switch...9.95

Switches an RF source to any one of several antennas or loads; unused outputs grounded. Use two to switch up to four different transmitters, receivers, etc. 1.1:1 max SWR to 250 MHz. 2 kW PEP max power rating.

Kit HD-1234, 2 lbs., mailable **9.95**

J) Heathkit hybrid Phone Patch...36.95

Individual rcvr-line & line-rcvr gain controls; VU meter. 30 dB isolation. Matches 3-16 ohm speakers & hi-Z or 600 ohm inputs. VOX or PTT. 2⅝" H x 9¼" W x 3⅝" D.

Kit HD-15, 3 lbs., mailable **36.95**

K) "Cantenna" dummy load...13.95

1 kW max input; 1.5-300 MHz w/SWR 1.5:1 or less. Oil not incl.

Kit HN-31, 3 lbs., mailable **13.95**

L) Heathkit Relative Power Meter...15.95

100 kHz — 250 MHz range; 0.3 V rms sensitivity; magnetic base.

Kit PM-2, 2 lbs., mailable **15.95**

M) Heathkit Mobile PTT Mike...10.95

Rugged, hi-Z ceramic mike ideal for mobile work. With cable, less connector. Excellent for "single banders."

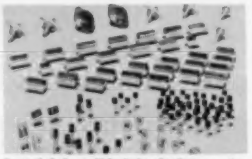
GH-12A, 1 lb., mailable **10.95**

N) Heathkit Mobile Speaker...12.95

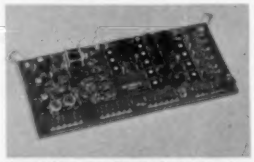
8 ohm speaker in rugged steel cabinet. Gimbal mount included. 6$^{1}/_{32}$ W x 4¾" H x 2½" D.

Kit HS-24, 4 lbs., mailable **12.95**

Heathkit SB-104 Series...our most



Completely solid-state design . . . including the finals. Over 275 solid-state devices, including 31 integrated circuits. **The SB-104 output board and final transistors are warranted for one full year.**



Completely broadbanded. Neither the transmitter nor receiver sections require tuning from 3 to 30 MHz . . . instant QSY from 80 to 10 meters is a reality.

Heathkit SB-104 Amateur Transceiver

Probably the world's most advanced amateur transceiver — totally broadbanded, completely solid-state, true digital readout and much more. This transceiver is the standard others will be judged by for years to come.

Totally broadbanded. You can go from CW on the low end of 80 to USB on the high end of 10 in just seconds — and with perfect tune. At last, instant QSY. Just choose the band, dial in the operating frequency, select your mode and go — no more preselector, load or tune controls.

True digital readout with 6 easy-to-read electronic digits provides resolution down to 100 Hz on all bands. There's no more need to rely on inaccurate dial tracking or questionable VFO linearity. True digital circuitry takes into account all three frequencies: VFO, HFO and BFO. You don't even need a calibrator.

Performance plus convenience. The transmitter delivers 100 watts output and, for QRP'ers, a front-panel switch instantly switches the output to one watt. And the four final transistors are protected against high SWR and thermal runaway, so they should never need replacement. The signal is clean and strong — low harmonic and spurious radiation, third-order distortion down 30 dB or better at 100 watts, carrier and unwanted sideband suppression down −55 dB. And broadbanding assures that it stays that way on all bands. Specifications alone don't do justice to the receiver's performance because we've dramatically reduced cross-modulation and intermodulation to increase useable sensitivity. And we didn't forget convenience — 15 MHz WWV position on the bandswitch, 30 kHz per revolution spinner knob, tune button for loading linears, PTT mike jack, pushbutton 100 Hz blanking, ALC/relative power/S-meter, switchable VOX with front-panel gain and delay, and much more.

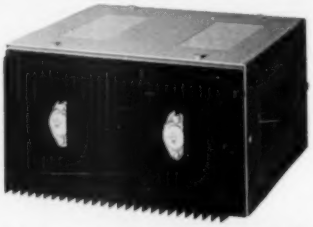
Easy assembly and alignment. Eleven of the 15 boards plug in and seven can be extended out of the chassis while the transceiver is operating. Two wiring harnesses eliminate most point-to-point wiring. Alignment is fast and simple requiring only a dummy load, mike and VTVM.

The SB-104 operates directly from a 12V auto electrical system. For fixed station use, hook up the HP-1144 Power Supply.

Kit SB-104, 31 lbs., mailable **669.95**
Kit HP-1144, Fixed station power supply, 28 lbs., mailable **89.95**
Kit SB-604, Speaker & cab., 8 lbs., mailable **29.95**
Kit SBA-104-1, Noise blanker, 1 lb., mailable **26.95**
Kit SBA-104-2, Mobile mount, 6 lbs., mailable **36.95**
Kit SBA-104-3, 400 Hz CW crystal filter, 1 lb., mailable **39.95**

SB-104 SPECIFICATIONS — TRANSCEIVER SECTION — GENERAL OPERATION: Frequency Coverage: 3.5 MHz through 29.7 MHz amateur bands, 15 MHz WWV receive only. **Frequency Stability:** Less than 100 Hz/hr drift after 30-min. warmup; less than 100 Hz drift for ±10% change in primary voltage. **Modes of Operation:** Selectable upper or lower sideband (suppressed carrier) and CW. **Readout Accuracy:** Within ±200 Hz ±1 count. **Audio Frequency Response:** 350 to 2450 Hz ±75 Hz (6 dB bandwidth). **Dial Backlash:** 50 Hz max. **Phone Patch Impedance:** 4 ohm output to speaker; high impedance output to transmitter. **Power Requirements:** 13.8 VDC nominal (max. 16 VDC) at: Receive: 2 amp. Transmit: low power: 3 amps.; high power: 20 amps. **TRANSMITTER: RF Power Output: High Power** (50 ohm non-reactive load). SSB: 100 watts PEP ±1 dB; CW: 100 watts ±1 dB. **Low Power** SSB: 1 watt PEP (minimum); CW: 1 watt (minimum). **Output Impedance:** 50 ohms, less than 2:1 SWR. **Carrier Suppression and Unwanted Sideband Suppression:** 55 dB down from 100 watt single-tone output at 1000 Hz reference. **Harmonic Radiation:** 45 dB below 100 watt output. **Spurious Radiation:** −50 dB within ±3 MHz of carrier; −60 dB farther than ±3 MHz from carrier, except −40 dB at 3.39 MHz on 80 meter band. **Third Order Distortion:** 30 dB down from two-tone output, reference at 100 watts PEP. **Transmit/Receive Operation:** SSB: PTT or VOX; CW: Keyed-tone VOX or manual. **CW Side-Tone:** Internally switched to speaker or headphones in CW mode. Approximately 700 Hz tone. **Microphone Input:** High impedance with a rating of −45 to −55 dB; approx. 25K ohms to match Heath desk-type microphone. **RECEIVER — Sensitivity:** Less than 1.0 microvolt for 10 dB signal-plus-noise-to-noise ratio for SSB operation. **Selectivity:** 2.1 kHz minimum at 6 dB down, 5 kHz maximum at 60 dB down. (2:1 nominal shape factor). **CW Selectivity:** (with accessory CW filter) 400 Hz at 6 dB down; 2 kHz max. at 60 dB down. **Overall Gain:** Less than 1 microvolt for 0.5 watt audio output. **Audio Output:** 2.5 watts into 4 ohms, 1.25 watts into 8 ohms, at less than 10% THD. Low impedance headphones (4-8 ohm). **AGC:** Less than 1 millisecond attack time; switch selectable 100 msec. and 1 sec. release, and OFF. **Intermodulation Distortion:** −65 dB min.; typically −57 dB with noise blanker. **Image Rejection:** −60 dB min. **IF Rejection:** −60 dB min. **Internally Generated Spurious:** Below 2 microvolt equivalent antenna input, except at 3.65, 3.74, 14.24 MHz and 21.2 MHz. **MECHANICAL — Rear Panel Controls/Sockets:** Anti-Trip; Sidetone Level; Linear Amplifier ALC Input; Phone Patch Input; Phone Patch Output; Key (CW) Input; Speaker (4 ohm) Output; Spare (2); Receiver Audio Input; VFO Input; VFO Output; IF Output; Driver Output; Ground Post; Power Plug; Accessory Socket (includes relay output); Antenna Input; Receiver Antenna Input; Common/Separate Antenna Switch. **Dimensions:** 5¾" H x 14⅞" W x 13⅞" D. (Less knobs, feet and connectors). **Weight:** 20 lbs.

Fixed Station Power Supply



120 V/240 VAC operated supply provides 13.8 VDC required by SB-104 Transceiver. Full-wave bridge circuit has triple Darlington regulation with an integrated circuit which samples, compares, and automatically adjusts transistor bias to maintain a fixed output level. Output is remotely sampled at the load end of the power cable, thereby compensating for voltage drop across fuse and cable, to provide almost no change in voltage from no load to full load conditions. Heat sink fits on back of supply; entire unit mounts within SB-604 speaker cabinet.

Kit HP-1144, Fixed-station supply, 28 lbs., mailable **89.95**

HP-1144 SPECIFICATIONS — Output Voltage: 13.8 VDC regulated (Adjustable from approximately 11 to 16 VDC). **Maximum Output Current:** 20 amperes, intermittent. 8 amps continuous. **Transistor Integrated Circuit and Diode Complement:** 2N3643 transistor; 2N3055 transistor; 40411 pass transistor (2); MFC6030 regulator IC; 1N4002 silicon diode; MDA990-2 bridge rectifier. **Power Requirements:** 110 to 130 VAC @ 6A or 220 to 260 VAC @ 3A, 50/60 Hz maximum. **Dimensions:** 5½" H x 9¼" W x 10¼" D. **Regulation:** Less than 2% output voltage variation from no load to 20 amperes. **Ripple:** Less than 1% at 20 amperes. **Fuses:** 7-amp, 3AG, slow-blow primary. 20-amp, 3AG, output. **Net Weight:** 23 lbs.

SB-604 Station Speaker

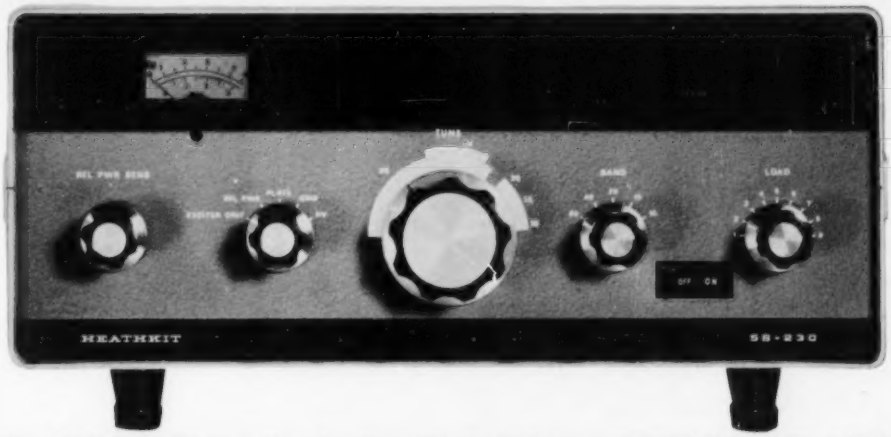
Designed and styled to match the new SB-104 Transceiver, the cabinet is large enough to house the HP-1144 AC Power Supply. The 5" x 7", 3.2 ohm speaker is response-tailored for SSB. Connector cable & plug are included.

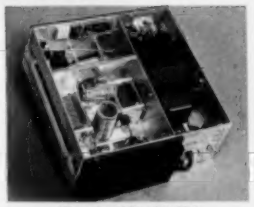
Kit SB-604, Speaker & cabinet, 8 lbs., mailable **29.95**

SB-604 SPECIFICATIONS — Speaker Size: 5" x 7" oval. **Voice Coil Impedance:** 3.2 ohms. **Frequency Response:** 300 to 3000 Hz. **Magnet Weight:** 3.16 oz. **Cabinet:** Aluminum with gray wrinkle finish. **Dimensions:** 7⅛" H x 10⅛" W x 14" D.

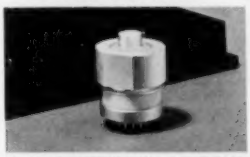
Heathkit performance specifications are guaranteed

sophisticated SSB transceiver system





Chassis of the SB-230.



The business end of the new SB-230: a conduction-cooled 8873 triode final and a highly efficient heat sink. No blower needed.

Heathkit SB-230 1kw Conduction-Cooled Linear

The new value in linears. The lowest cost conduction-cooled linear on the market.

Strong and silent. The "230" uses a husky Eimac 8873 triode in proven, stable, grounded grid circuitry to deliver up to 1200 watts PEP SSB, 1000 watts CW input from less than 100 watts drive. The "230" is also rated at 400 watts input for slow-scan TV and RTTY. A massive heat sink eliminates noisy cooling fans. And the final is completely enclosed in a double-shielded compartment.

Convenience. Bandswitching is done with a single knob...Load and Tune controls are clearly marked so you can return to a favorite operating frequency just by noting the control positions. A five-position switch, coupled with the back-lighted meter, indicates Relative Power, Plate current, Grid current and plate High Voltage at a glance. Relative Power sensitivity is adjustable with the front panel knob.

A full complement of built-in safety features. The cabinet features microswitch interlocks on both the top and bottom to shut down the primary power when the cabinet shells are removed. The heat sink for the 8873 is temperature monitored; if the temperature rises too high, a thermal circuit breaker opens, the linear shuts down and the HI Temp light goes on. The Exciter light indicates the linear is running straight through, without amplification. To allow the tube sufficient time to warm up, a delay circuit is built-in. The On-Off switch also includes a built-in circuit breaker for the primary side of the power transformer. And the cathode of the tube is fused for additional protection.

Kit SB-230, 40 lbs., mailable **339.95**

SB-230 SPECIFICATIONS: Band Coverage: 80, 40, 20, 15 and 10 meter amateur bands. **Maximum Power Input:** 1200 W PEP SSB; 1000 W CW; 400 watts RTTY/SSTV. **Duty Cycle: SSB:** continuous voice modulation; **CW:** continuous (max. key-down time 30 seconds); **RTTY/SSTV:** 50% (max. transmit time 10 minutes at 400 watts). **Driving Power Required:** less than 100 W. **Third Order Distortion:** —30 dB or better. **Output Impedance:** 50 ohms at 2:1 SWR max. **Input Impedance:** 52 ohms at 1.5:1 SWR max. **Rear Panel:** ALC output; Exciter relay; RF input; RF output; Ground lug; Fuse; Line cord. **Tube:** Type 8873. **Zero signal plate current:** 25 mA. **Power Requirements:** 120 VAC, 50/60 Hz, 14 A max. 240 VAC, 50/60 Hz, 7 A max. **Dimensions:** 14¾" W x 16" D x 7" H. **Net Weight:** 33½ lbs.

SB-614 Station Monitor

Monitors transmitted SSB, CW, & AM signals up to 1 kW from 80-6 meters. CRT indicates non-linearity, insufficient or excessive drive, poor carrier or sideband suppression, regeneration, parasitics and CW key clicks. Manual includes 40 CRT displays and explanations.

Kit SB-614, 17 lbs., mailable **139.95**

SB-614 SPECIFICATIONS — RF SAMPLING SECTION: Frequency Coverage: 80 through 6 meters (3.5 — 54 MHz). **RF Power Limits:** Exciter input (50 — 75 ohm) 10 to 300 watts; Antenna input (50 — 75 ohm) 10 to 1000 watts. **Insertion Loss:** Negligible. **VERTICAL AMPLIFIER: Input Impedance:** 1 Megohm shunted by 75 pf. **Sensitivity:** 60 mV rms/¼" vertical deflection. **Attenuator:** 2 position; x1, 2 volts rms max. input; x10, 20 volts rms max. input. **Frequency Response:** 10 Hz to 50 kHz ±3 db. **HORIZONTAL AMPLIFIER: Input Impedance:** 1 Megohm shunted by 50 pf. **Sensitivity:** 50 mV rms/¼" horizontal deflection. **Frequency Response:** 10 Hz to 3 MHz ±3 dB. **SWEEP GENERATION: Type:** Recurrent, automatic sync. **Frequency Range:** 10 Hz to 10 kHz in three ranges. **GENERAL: CRT:** 3RP1/A flat face, green, medium persistence phosphor. **Graticule:** .250 inch squares 6 x 8 (1.5 x 2.0 inches total viewing area). **Power Supplies:** All solid-state rectifiers. All amplifier supplies regulated. **Power Requirements:** 110-130 or 220-260 VAC, 50/60 Hz, 35 watts. **Front Panel Controls:** Intensity — Off-on; Mode — SSB, TRAP, CROSS; Focus; Vertical Gain; Vertical Position; Horizontal Gain; Horizontal Position; Sweep — variable; Range — 100 Hz, 1 kHz, 10 kHz. **Rear Panel Controls:** Astigmatism; Vertical attenuator —X1, X10. **Rear Panel Connectors:** Antenna: SO-239; Exciter: Phono; Vertical Input: Phono; Horizontal Input: Phono. **DIMENSIONS:** 7¼" H x 10¼" W x 15¼" D. **Net Weight:** 12 lbs.

SB-634 Station Console

Provides five necessary station functions every amateur needs. 24-hour digital clock; ten-minute ID timer; RF wattmeter; SWR bridge; phone patch.

Kit SB-634, 14 lbs., mailable **179.95**

SB-634 SPECIFICATIONS — CLOCK — Display: Six full digits. **Time Base:** 24 hours. **Accuracy:** Determined by accuracy of power line frequency. **TIMER — Display:** Three full digits. **Time Interval:** 10 minutes with automatic reset. Manual reset at any portion of 10-minute period. **Accuracy:** Determined by accuracy of power line frequency. **Signal:** Visual only or both visual and aural; switch selected. **RF POWER/SWR METER — Frequency Range:** 1.8 to 30 MHz. **Wattmeter Accuracy:** ±10% of full-scale reading. **Power Handling Capability:** 2000 watts (maximum). **SWR Sensitivity:** Less than 10 watts. **Impedance:** 50 ohm nominal. **Connectors:** UHF type SO-239. **PHONE PATCH — Circuit:** Telephone hybrid circuit. Allows voice control or manual operation. **TELEPHONE LINES — Input Impedance:** Approximately 600 ohm. **Null Depth:** At least 30 dB isolation between transmit and receive circuits. **Receiver Impedance:** Effective match from 3 to 16 ohm. **Transmitter Impedance:** 600 ohm or higher impedance output. **GENERAL — Meter:** 100 μA movement. VU readings for phone patch monitoring. Null depth indication. RF power output, relative power, and SWR readings. **FRONT PANEL CONTROLS — Timer:** Off, Visual, Aural Visual. **Reset:** Pushbutton switch. **Patch Gain:** Transmitter, Receiver. **SWR:** Sensitivity. **Mode:** SWR, Forward and Reflected. 2000 W and 200 W. Phone Patch. **Rear Panel Controls — Clock:** Time hold, minutes set, seconds set. Null Adjust control; Null-Monitor switch; C adjust control; R adjust control. **Power Requirements:** 120/240 VAC, 50/60 Hz, 15 watts. **DIMENSIONS:** 7¼" H x 10¼" W x 15¼" D. **Net Weight:** 10 lbs.

SB-644 Remote VFO

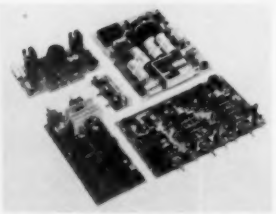
Designed exclusively for use with the SB-104. Provides split transmit/receive capability without a separate transmitter and receiver. Multimode capability allows transceive operation on either the "644" or the "104." Use either of the two crystal positions in the "644" for fixed-frequency control. Convenient front panel controls for all transceive, transmit or receive modes on both the "104" and the remote VFO. "644" tuning scale gets you into the right frequency area, exact frequency readout takes place in the "104." Switch from transmit to receive and the display automatically changes to the correct frequency. The "644" uses the same kit VFO as the SB-104. And the true digital frequency readout in the "104" eliminates concern about dial VFO linearity problems. "644" assembles easily, with minimal adjustments, and requires no modifications to "104".

Kit SB-644, 10 lbs., mailable **119.95**

SB-644 SPECIFICATIONS — Frequency Coverage: 5.0 — 5.5 MHz allowing 80, 40, 20, 15, 10 meter operation in the SB-104. **Frequency Stability:** Less than 100 Hz drift per hour after thirty minute warmup. **Modes of Operation:** Remote VFO; Main VFO; Receive Remote/Transmit Main; Receive Main/Transmit Remote; Crystal frequencies (2) (crystals not supplied). **Dial Backlash:** 100 cycles max. **Power Requirements:** 11V and 13.6V at 500 mA from the SB-104. **RF Output:** 0.34 to 0.4V RMS over 5 to 5.5 MHz into a 50 ohm load. **DIMENSIONS:** 7¼" H x 10¼" W x 15¼" D. **Net Weight:** 6½ lbs.

You get more Scope Performance

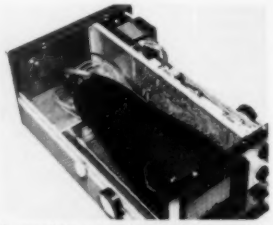
Kit or Assembled



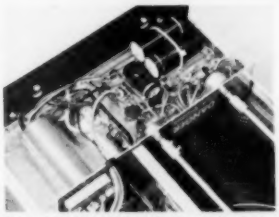
All major circuitry is contained on five easily removed circuit boards.

Adjustable line voltage switch matches the power supply of the IO-4510 to any voltage from 100 to 280 VAC.

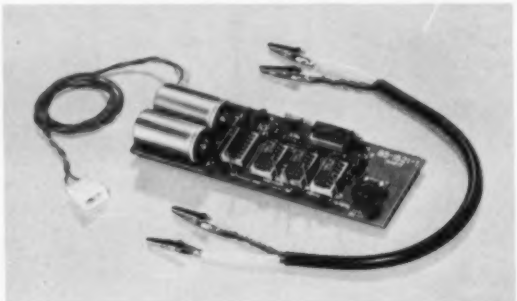
Kit or Assembled



A complete mu-metal shield is used in the IO-4530 to eliminate display error caused by electromagnetic interference.



The regulated high voltage supply is located in its own shielded compartment for complete isolation.



Oscilloscope Calibrator

The Heathkit IOA-4510-1 is a easy-to-build, easy-to-use crystal-controlled time base designed by Heath's 'scope engineers for oscilloscope calibration. It provides everything you need to accurately calibrate your new Heathkit IO-4510 or IO-4530. It generates a square wave signal with selected ranges from 1 MHz to 1 kHz at TTL output levels. The 1 kHz output level can be adjusted from 0 to 4.7 volts peak.

Kit IOA-4510-1, 1 lb., mailable **14.95**

per Dollar when You buy Heath

Our best scope — dual trace, DC to 15 MHz, 1 mV sensitivity...569.95 Kit, 775.00 Assembled

The Heathkit IO-4510 has vertical delay lines, 45 MHz typical trigger bandwidth and a maximum sensitivity of 1 millivolt over full vertical bandwidth. With a x10 probe, you can read waveforms to 10 mV/cm. The attenuator networks can be switched through 12 calibrated ranges to set deflection factors from 1 mV/cm to 5 V/cm.

Digitally-controlled time base circuitry provides automatic triggering for easy operation—no stability control is necessary. A reference baseline is generated when trigger signal is absent. Trigger Select switch and Level control allow time base to be precisely triggered at any point along positive or negative slope of trigger signal.The automatic position of level control triggers at zero crossing point.

Modes of signal display are selected by position control for each channel and Time Base switch. Either channel can be displayed as a function of time, or both can be displayed together chopped (200 kHz) or alternate modes automatically selected by time base switch. X-Y operation uses Channel 1 for horizontal deflection and Channel 2 for vertical deflection. Time Base control provides 22 calibrated time bases from 0.2 sec/cm to 0.1 μsec/cm in 1, 2, 5 sequence, continuously variable between switch positions.

An adjustable AC line switch matches the regulated power supply to any common line voltage from 100 volts to 280 volts AC. All major circuitry is contained on five circuit boards for easy trouble-shooting. And push-on connectors permit fast removal of any board. The 6 x 10 cm CRT has post-deflection acceleration for a brighter trace and faster writing speeds.

Calibration of the IO-4510 requires a precise source of square waves to insure calibration to published specifications. Waveforms should be 5 volt, 1 kHz to 1 MHz square waves, with less than 5 nsec rise time and less than 1% overshoot. If a source is not available, the IOA-4510-1 Oscilloscope Calibrator (described below) may be ordered.

Kit IO-4510, 34 lbs., mailable **569.95**

Assembled SO-4510, factory wired & calibrated version of the IO-4510, 34 lbs., mailable **775.00**

IO-4510 SPECIFICATIONS—VERTICAL: Deflection Factor: Sensitivity: 1 mV/cm to 5 V/cm. **Attenuator:** 12 steps in 1-2-5 sequence. **Variable:** Continuous between steps to approx. 15 V/cm. **Accuracy:** Within 3%. **Vertical Response: DC Coupling:** DC to 15 MHz. **AC Coupling:** 2 Hz to 15 MHz. **Rise Time:** 24 ns. **Overshoot:** <3%. **Delay Line:** Allows display of at least 20 ns of pre-triggered waveform. **Vertical Input: Impedance:** 1 MΩ shunted by ≈40 pF. **Maximum Input:** 400 V. **HORIZONTAL: Time Base: Ramp:** 0.2 S/cm to 100 ns/cm. **Positions:** 20 steps in 1-2-5 sequence. **Variable:** Continuous between ranges to approximate 0.6 Sec/cm. **Accuracy:** Within 3%. **Magnifier:** X5 (adds additional 2% to sweep accuracy). **External: Sensitivity:** 0.2 V/cm (approx.). **Impedance:** 200 kΩ (approx.). **Polarity:** Neg. input causes right hand deflection. **Frequency Response:** DC to 1 MHz. **TRIGGER: Internal: Automatic:** Zero crossing ±0.5 cm. **Normal:** Adjustable over 8 division. **Slope Selection:** + or —. **Sensitivity/Bandwidth:** 1 cm deflection—DC, auto & norm: DC to 30 MHz; AC auto: 15 Hz to 10 MHz; AC norm: 10 Hz to 30 MHz; ACF auto: 20 kHz to 10 MHz; ACF norm: 10 kHz to 30 MHz. **External: Automatic:** Zero crossing ±0.2 V. **Normal:** Adjustable over ±5 V. **Slope Selections:** + or —. **Sensitivity/Bandwidth:** 0.5 V external trigger level—DC, auto & norm: DC to 30 MHz; AC auto: 10 Hz to 20 MHz; AC norm: 5 Hz to 30 MHz; ACF auto: 10 kHz to 20 MHz; ACF norm: 5 kHz to 30 MHz. **Impedance:** 1 MΩ shunted by ≈30 pF. **X-Y: Y Channel:** Same as vertical. **X Channel:** Same as vertical, except response limited to 1 MHz and no delay line. **Phase Shift:** Less than 3° @ 100 kHz. **GENERAL: CRT: Type:** 6 x 10 cm spiral PDA. **Acceleration Potential:** 4 kV regulated. **Phosphor:** P31. **Graticule:** 6 x 10 cm illuminated. **Power: Voltage Range:** 100-140/200-280 VAC, switch selected, 75 W. **Internal Supplies:** Fully regulated. **Operating Temperature Range:** 10°C to 40°C. **Dimensions:** 6.4" H x 12.9" W x 19.3" D (without handle).

Heathkit IO-4530...perfect for TV service & home experimenting... 299.95 Kit, 425.00 assembled

You won't find a better TV service oscilloscope value than the Heathkit IO-4530. Features like TV coupling, DC-10 MHz bandwidth, wideband triggering capability, sensitive 10 mV/cm vertical input, and calibrated X-channel input make it a versatile, easy-to-use scope for the service technician and a good general purpose scope for the hobbyist.

The 4530 is one of the few single-trace scopes available with two input channels. The Y-input has a maximum sensitivity of 10 mV with an 11-position attenuator to set deflection from 10 mV/cm to 20 V/cm. For true X-Y operation, a calibrated X-input is provided with maximum sensitivity of 20 mV. Its calibrated 3-position attenuator can be switched through three AC or DC ranges from 20 mV/cm to 2 V/cm.

High or low frequency waveforms are no problem since the 4530's wide range of time bases can be switched from 200 ms/cm to 200 ns/cm. Any sweep speed can be expanded five times.

Trigger circuits are digitally controlled, requiring only a Level control and a Slope switch. In automatic mode, the triggering is at the zero crossing point. In normal mode, the level control is adjustable over the complete 8 cm span. Various trigger signals can be selected: a sample of the vertical input signal, a sample of the line voltage or an externally applied trigger signal. In the TV trigger coupling mode, the 4530 can be easily triggered on the vertical signal in a complex TV signal. Calibration requires a source of 1 volt, 10 kHz to 1 MHz square waves with less than 7 ns rise time and less than 1% overshoot (see IOA-4510-1 Oscilloscope Calibrator, page 68).

Kit IO-4530, 30 lbs., mailable **299.95**

Assembled SO-4530, factory wired & calibrated version of IO-4530, 28 lbs., mailable **425.00**

IO-4530 SPECIFICATIONS—VERTICAL: Deflection Factor: Sensitivity: 10 mV/cm to 20 V/cm. **Attenuator:** 11 steps in 1, 2, 5 sequence. **Variable:** Continuous between steps to approx. 50 V/cm. **Accuracy:** Within 3%. **Vertical Response: DC Coupling:** DC to 10 MHz. **AC Coupling:** 2 Hz to 10 MHz. **Rise Time:** 35 ns. **Overshoot:** <5%. **Vertical Input: Impedance:** 1 MΩ shunted by ≈38 pF. **Maximum Input:** 400 V. **HORIZONTAL: Time Base: Ramp:** 0.2 S/cm to 200 ns/cm. **Positions:** 7 steps in decade sequence. **Variable:** Continuous between ranges to approximate 2 s/cm. **Accuracy:** Within 5%. **Magnifier:** X5 (adds additional 2% to sweep accuracy). **External: Deflection Factor: Sensitivity:** 0.02 V/cm to 2 V/cm. **Attenuation:** 3 steps in decade sequence. **Variable:** Continuous between steps to approx. 20 V/cm. **Accuracy:** Within 3%. **Response: DC Coupling:** DC to 1 MHz. **AC Coupling:** 2 Hz to 1 MHz. **Rise Time:** 0.35 ns. **Overshoot:** <5%. **Input: Impedance:** 1 mΩ shunted by ≈40 pF. **Max. Input:** 400 V. **TRIGGER: Internal: Automatic:** Zero crossing ±0.5 cm. **Normal:** Adjustable over 8 divisions. **Slope Selection:** + or —. **Sensitivity/Bandwidth:** 0.5 cm deflection—DC, auto & norm: DC to 5 MHz; AC, auto & norm: 40 Hz to 5 MHz; TV, auto & norm: 40 Hz to 1 MHz. 1 cm deflection—DC, auto & norm: DC to 10 MHz; AC, auto & norm: 40 Hz to 10 MHz. 1.5 cm deflection—DC, auto & norm: DC to 15 MHz; AC, auto & norm: 40 Hz to 15 MHz. **External: Automatic:** Zero crossing ±0.03 V. **Normal:** Adjustable over 1.2 V. **Slope Selections:** + or —. **Sensitivity/Bandwidth:** 0.5 V. external trigger level—DC, auto & norm: DC to 5 MHz; AC, auto & norm: 40 Hz to 5 MHz; TV, auto & norm: 40 Hz to 1 kHz. 1 V external trigger level—DC, auto & norm: DC to 15 MHz; AC, auto & norm: 40 Hz to 15 MHz. **Impedance:** 1 MΩ shunted by ≈40 pF. **X-Y: Y Channel:** Same as vertical. **X Channel:** Same as external horizontal. **Phase Shift:** Less than 5° @ 100 kHz. **GENERAL: CRT: Type:** 5" round. **Acceleration Potential:** 1.4 kV regulated. **Phosphor:** P31. **Graticule:** 8 x 10 cm. **Power: Voltage Range:** 110-130/220-260 VAC, switch selected, 65 watts. **Internal Supplies:** Fully regulated. **Operating Temperature Range:** 10°C to 40°C. **Dimensions** 6.4" H x 12.8" W x 19.2" D (without handle).

Heathkit ID-101 Electronic Switch

Provides simultaneous display of two separate input signals on a single trace scope by alternating between inputs. Response is DC-5 MHz, + 1½ dB, — 3 dB.

Kit ID-101, 6 lbs., mailable **44.95**

ID-101 SPECIFICATIONS—Signal gain: >10 times. **Maximum input signal:** 600 VDC or 600 VAC p-p. **Input impedance:** 1 megohm/50 pF. **Maximum signal output:** 8 V p-p. **Output loading:** 1000 ohm minimum. **Hum and noise:** (single channel only). <40 mV p-p. **Chopping rates:** Approx. 100, 500, 1000 and 5000 Hz. **Power requirements:** 120/240 V, 50-60 Hz, 6 W. **Dimensions:** 4¼" H x 10⅜" W x 5¾" D.

Hobbyist or professional, there's a Heath

Kit or Assembled

A)

The all solid-state circuitry of the IM-1212 is contained on a single circuit board for easy assembly and access when servicing.

B)

- *Truly portable — includes rechargeable nickel-cadmium batteries and built-in charger*
- *26 ranges; resolves voltages to 100 μV, currents to 100 nA; measures AC & DC current up to 2 A*
- *Built-in references for easy field calibration*
- *Compact size—only 3" H x 8¼" W x 8" D*
- *Automatic polarity indication*
- *Uses patented Schlumberger dual-slope conversion technique . . . the industry standard for DMMs*

These "how-to" books help you get maximum use & enjoyment from your Heathkit meter.

Handbook of Practical Electronic Tests & Measurements, a guide to the basic theory and application of every practical electronic test & measurement procedure for technicians, **EDP-137** 16.95*

101 Ways to Use Your VOM/VTVM, covers equipment checks, ac & dc voltage tests, dc current tests, ohmmeter tests, signal tracing tests, alignment & color TV tests, **EDP-150** 4.50*

101 More Ways to Use Your VOM/VTVM, expands on volume above, describing additional tests & uses. **EDP-151** 4.50*

Understanding & Using the VOM & DVM, a modern, practical guidebook to every possible application of the VOM. **EDP-140** 4.95*

Electronic Measurements Simplified, covers nearly every test or measurement you'll ever have to make in TV servicing, 2-way & ham radio, CB, etc., — in plain English. **EDP-141** 4.95*

ABCs of Electronic Test Probes, shows how to use the many probes needed for testing radio, TV & other equipment. **EDP-143** 2.95*

*$10 minimum order for book **only** purchase. No minimum when book order accompanies kit order. Includes 35¢ for each book to cover postage and handling.

C)

DMM for your measurement need

A) Our lowest cost DVM—now in a bench version...only 79.95 Kit, 125.00 Assembled

- Large, bright, easy-to-read display
- Completely self-calibrating
- For hobbyists, schools, and service techs

The new Heathkit IM-1212 Digital Multimeter is the low-cost DMM that hams, hobbyists and service techs have been waiting for. Its full-function capability even includes AC voltage measurements up to 700 volts. Four overlapping AC & DC voltage & current ranges and five resistance ranges make operation fast and simple. Accuracy is very good for a multimeter in this price range: 1% on DC volts, 1½% on AC volts and AC/DC current, and 2% on resistance. Lighted front-panel indicators show overrange, positive and negative DC voltages and current at a glance.

The all solid-state design uses IC circuitry for a clear non-blinking display. The dependable ramp analog-to-digital converter updates the readout every 16 msec.

The IM-1212 is a great teaching aid for schools. It's simple to operate, and the large 2½-digit display with automatic decimal positioning ends "reading the wrong scale" errors. The easy assembly makes it a great project for student electronics labs. And the exclusive Heath built-in calibration standards are all that's needed for those initial and periodic adjustments.

Other features include overload protection on all ranges... 120 or 240 VAC operation... isolated floating ground... attractive heavy-duty case to withstand rugged use... universal banana jack inputs.

Kit IM-1212, 7 lbs., mailable **79.95**

Assembled SM-1212, wired version of the IM-1212, 7 lbs., mailable **125.00**

IM-1212 SPECIFICATIONS — Functions: ±DC volts, ±DC current, AC volts, AC current, ohms. **Ranges:** (full scale): DC volts: 2, 20, 200, 1,000V. DC current: 2, 20, 200, 2,000 mA. AC volts: 2, 20, 200, 700V rms (25 Hz to 10 kHz). AC current: 2, 20, 200, 2,000 mA rms (25 Hz to 10 kHz). Ohms: 200, 2k, 20k, 200k, 2,000k ohms. **Maximum input without damage:** 3 A into AC or DC mA, and ohms (fuse protected). 700 VAC rms into volts (except 2V range—140 VAC rms). 1000 VDC into volts (except 2V range—200 VDC). **Resolution:** (Lowest Range) Volts: 10 mV. Current 10μA. Ohms: 1 ohm. **Display:** Two & one half digit numeric. Rated accuracy carried to 25% overrange. **Accuracy:** (Full scale ±1 digit): 1% DCV (1000 V max.), 1½% ACV (700V max.), AC & DC current, 2% ohms. **Input Impedance:** 1 megohm on all voltage ranges. 2V drop maximum on current ranges. **Sample Rate:** Approximately 60 per second. **Power requirements:** 120/240 VAC, 50/60 Hz, 8 watts. **Dimensions (overall):** 3¼" H x 9¼" W x 8¾" D.

B) Heathkit IM-2202 Portable Digital Multimeter — "Pro" performing compact...only 179.95

The Heathkit IM-2202 Portable Digital Multimeter is the lowest priced professional-grade digital multimeter we've ever offered. Designed for field or bench use, it will provide years of dependable measurement. Included are four rechargeable nickel-cadmium batteries that provide up to eight hours of continuous operation with each charge. It may also be operated from 110 or 220 VAC or temporarily from four "C" cells.

Its 26 ranges include AC and DC voltages, AC and DC current, resistance and a Battery Test position. Full scale ranges are 100 mV to 1000 volts DC, 100 mV to 750 volts AC, 100 μA to 1000 mA and 100 ohms to 1000 kilohms. 100% overrange allows measurements up to 1.999 on all ranges except 1000 VDC and 750 VAC, giving full 2 amp or 2 megohm capability. Voltage and current inputs are separated for circuit protection. All functions are protected against accidentally applied voltages up to 250 volts. Overrange is indicated by a flashing "1" display.

All voltage ranges have high input impedance (10 megohms typical) to prevent circuit loading. Current ranges feature low voltage drop (100 mV typical) for accurate measurements. Resistance ranges limit maximum test current to 1 mA. The full scale measurement of 2 volts on the 1 kilohm, 10 kilohm and 1 megohm ranges still allows forward-biased junction testing of semiconductor devices.

If a lab standard is used for calibration, DC accuracy is ±0.2%; AC accuracy is ±0.5% to 10 kHz. Internal standards supplied allow field calibration to ±0.5% for DC and ±1% for AC.

The large 3½-digit display (1999 count) is easy to read, even in bright sunlight. Automatic polarity indication and decimal point placement reduce the possibility of erroneous readings. A continuous-rotation Range switch and four pushbutton Function switches select ranges.

A custom-designed MOS/LSI integrated circuit contains all digital counting and logic circuits — allowing the extensive circuitry of the IM-2202 to be contained in its compact case. It provides leading zero suppression for all measurements to conserve battery charge and insures a stable, flicker-free display. It functions as the heart of a dual-slope analog-to-digital converter providing stable, accurate performance under all conditions of temperature and battery charge.

Although assembly of the IM-2202 is aided by circuit board construction and many "plug-in" components, previous kitbuilding experience would be helpful. If you've ever built an electronic kit, you'll appreciate the advanced techniques and engineering concepts used in its design. Professional features, easy operation, high accuracy and dependable performance — you get them all with the Heathkit IM-2202.

Kit IM-2202, 7 lbs., mailable **179.95**

IM-2202 SPECIFICATIONS

NOTE: Accuracy specifications of the IM-2202 depend on use of built-in references or laboratory standard references for calibration.

DC VOLTAGE — Range/Input Impedance: 100.0 mV/50 MΩ, 1.000 V/500 MΩ, 10.00 V/10 MΩ, 100.0 V/10 MΩ, 1000 V/10 MΩ. **Overload Capability:** 300 V on 100 mV & 1 V ranges; 1000 V on 10 V, 100 V & 1000 V ranges. **Accuracy:** Built-in references, ±0.5%, ±1 digit. Laboratory standards. ±0.2%, ±1 digit. **Temperature coefficient:** ±200 PPM/°C. **AC VOLTAGE — Range/Input Impedance:** 100.0 mV/10 MΩ-120 pF, 1.000 V/10 MΩ-120 pF, 10.00 V/10 MΩ-60 pF, 100.0 V/10 MΩ-60 pF, 750 V/10 MΩ-60 pF. **Overload Capability:** 250 V on 100 mV & 1 V ranges; 750 V on 10 V, 100 V & 750 V ranges. **Accuracy:** Built-in references... ±1.0%, ±3 digits; 40 Hz to 1 kHz (except 40 Hz to 10 kHz on 100 mV and ranges). Laboratory standards... ±0.5%, ±3 digits; 40 Hz to 10 kHz (except 40 Hz to 2 kHz on 750 range). **Temperature coefficient:** ±300 PPM/°C. **DC CURRENT — Range/Voltage Drop:** 100.0 μA/100 mV, 1.000 mA/100 mV, 10.00 mA/100 mV, 100.0 mA/150 mV, 1000 mA/300 mV. **Accuracy:** Built-in references... ±0.5%, ±1 digit (except ±1%, ±1 digit on 1000 mA range). Laboratory standards... ±.2%, ±1 digit (except ±.5%, ±1 digit on 1000 mA range). **Temperature coefficient:** ±250 PPM/°C. **Overload protection:** Input coupled through 3.0 Ampere fuse to shunt diodes for overloads above approximate 1.2 Volts. **AC CURRENT — Range/Voltage Drop:** 100.0 A/100 mV, 1.000 mA/100 mV, 10.00 mA/100 mV, 100.0 mA/150 mV, 1000 mA/300 mV. **Accuracy:** Built-in references... ±1.0% ±3 digits (except ±1.5%, ±3 digits on 1000 mA range); 40 Hz to 10 kHz. Laboratory references... ±.5%, ±3 digits (except ±1.0%, ±3 digits on 1000 mA range); 40 Hz to 10 kHz. **Temperature coefficient:** 350 PPM/°C. **Overload protection:** Input coupled through 3.0 Ampere fuse to shunt diodes for overloads above approximate 1.2 Volts. **RESISTANCE — Range/Test Current:** 100.0 Ω/1.0 mA, 1.000 kΩ/1.0 mA, 10.00 kΩ/0.1 mA, 100.0 kΩ/1.0 μA, 1000 kΩ/10. μA. **Accuracy:** Built-in references... ±.5%, ±1 digit. Laboratory standards... ±.2%, ±1 digit. **Temperature coefficient:** ±300 PPM/°C. **Open-circuit voltage:** 12 VDC. **Overload protection:** Positive input over-voltage protection by blocking diode to 400 volts; negative input over-voltage through 0.03 A fuse and shunt diode.

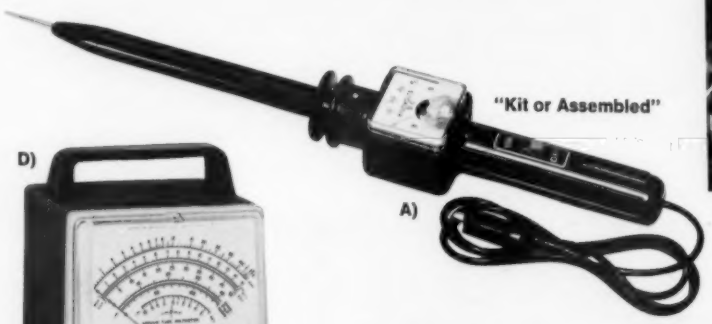
GENERAL — Overrange Capability: 100% on all ranges except 1000 VDC & 750 VAC. **Display:** 1999 maximum; seven segment planar; 0.55" high digits. **Polarity indication:** Automatic "+" and "—". **Overrange indication:** Automatic above 1999; polarity sign and decimal point shown with flashing "1" in thousands. **Display rate:** Approximately 5 per second, non-blinking. **Normal mode rejection:** 35 dB (line operation); extended on battery operation. **Common mode rejection:** 80 dB (line operation); extended on battery operation. **Power line isolation:** May be operated 1500 V above power line ground (during line operation). **Operating temperature range:** 10°C to 40°C. **Storage temperature range:** —40°C to 50°C with batteries installed; to 70° with batteries removed. **Power requirements:** 110 to 130 VAC, or 220 to 260 VAC (internal selectable); 50/60 Hz; 5 watts typical during charge. **Operating time:** 8 hours typical after 14 hours minimum charge time (from internal nickel-cadmium batteries). Standard "C" batteries may be used for intermittent operation up to 2 hours for Zinc — Carbon (NEDA type 14) and up to 6 hours for Alkaline (NEDA type 14A). Built-in "Battery Test" function provided. **Size (overall including handle folded to rear):** 3" H x 8¼" W x 8" D.

C) Our finest DVM...3½ digits...high accuracy & resolution...249.95

Kit IM-102, 9 lbs., mailable **249.95**

IM-102 SPECIFICATIONS — DC VOLTMETER — 5 ranges: 200 mV, 2V, 20V, 200V, 1000V. **Input Impedance:** Approx. 100 megohm on 200 mV, approx. 1000 megohm on 2V, 10 megohm on all other ranges. **Accuracy:** ±0.2% ±1 digit with furnished DC calibrator, ±0.1% ±1 digit with lab calibration. **Overload protection:** 350V on 200 mV and 2V, 1000V on other ranges. **Overrange capability:** 20% minimum (subject to overload protection limits). **Resolution:** 100 μV. **Full scale step response:** 2 sec. to rated accuracy. **Input bias current:** 10 nA maximum at reference conditions. **Temperature influence:** ±0.005%/°C., ±1 digit/°C. **Normal mode rejection:** 35dB minimum @ 60 Hz. **Common mode rejection:** 80 dB minimum with 1k unbalance @ 60 Hz. **OHMMETER — 6 ranges:** 200 ohms with 1 mA test current, 2k with 100μA, 20k with 10μA, 200k with 10μA, 2M with 1μA, 20M with 100nA. **Accuracy:** With DC calibrator, ±0.5% ±1 digit on 200, 2k, 20k, 200k ranges; ±1.5% ±1 digit on 2M and 20M ranges. With lab calibration, ±0.5% ±1 digit on 200 ohm range; ±0.25% ±1 digit on 2k, 20k, 200k; ±1% ±1 digit on 2M and 20M. **Overload protection:** 250 V rms. **Resolution:** 0.1 ohm (200 ohm range). **Full scale step response:** 2 sec. on ohm and k ohm ranges, 10 sec. at 10 megohms to rated accuracy. **Temperature influence:** ±0.05% @ 0°C. **Overrange capability:** 20% minimum. **AC VOLTMETER** (Average responding, rms calibrated) — 5 ranges: 20 mV, 2 V, 20 V, 200 V, 1000 V. **Input impedance:** 1 megohm @ 150 pF. **Overload protection:** 250 rms on 200 mV and 2 V, 500 V on higher ranges. **Accuracy:** With DC calibrator, ±0.75% ±1 digit for 40Hz-10kHz, ±1% ±1 digit for 10kHz-20kHz on 200 mV and 2V ranges: ±0.75% ±1 digit for 40Hz-5kHz, ±1.5% ±1 digit for 5kHz-10kHz on 20V and 200V ranges: ±1.5% ±1 digit for 40Hz-7.5kHz on 1000V range. **DC AMMETER — 5 ranges:** 200μA, 2mA, 20mA, 200mA, 2A. **Voltage drop:** 0.2V (nominal). **Accuracy:** With DC calibrator, ±0.5% ±1 digit for 2A, ±0.3% ±1 digit on all other ranges. With lab calibration, ±0.25% ±1 digit for 2mA and 20mA; ±0.3% ±1 digit for 200mA; ±0.5% ±1 digit for 2A. **Resolution:** 100 nanoamperes (200μA range). **Overload protection:** 3 A, any range, by fuse and clamp diodes. **AC AMMETER** (40Hz-10kHz) — **5 ranges:** 200μA, 2mA, 20mA, 200mA, 2A. **Voltage drop:** 0.2 V (nominal). **Accuracy:** With DC calibrator, ±1.5% ±1 digit on 2A, ±1% on all other ranges. With lab calibration, ±0.75% ±1 digit on 200μA, ±0.7% ±1 digit on 2 mA and 20 mA; ±0.8% ±1 digit on 200mA; ±1% ±1 digit on 2A. **Resolution:** 100 nanoamperes. **Overload protection:** 3A, any range, by fuse and clamp diodes. **GENERAL — Display:** Maximum count, 1999. Overrange indication, automatic beyond 1999. Polarity indication automatic "+" or "—". Reading rate, 5 per sec., non-blink (200 millisecond integration time). Numeric display by side-viewing neon glow tubes with integral decimal points. **Power requirement:** 120 or 240 VAC, 50Hz/60Hz, 8 W nominal. **Operating temperature:** 10°C-40°C. **Reference:** 25°C. ±1°C. **Size:** 3" H x 7" W x 7.9" D.

Build Heathkit meters

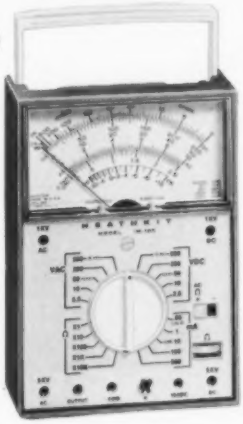


"Kit or Assembled"

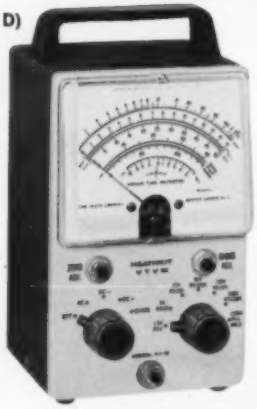
A)

"Kit or Assembled"

B)



D)

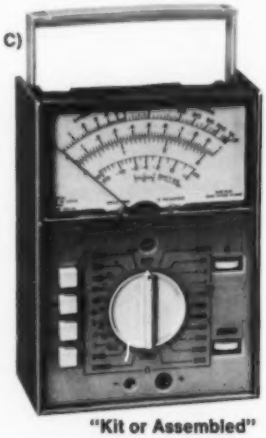


"Kit or Assembled"

E)

"Kit or Assembled"

C)



"Kit or Assembled"

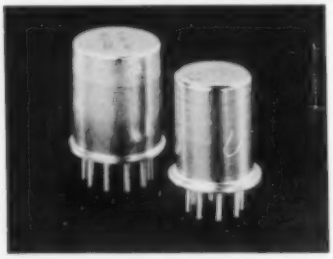
F)

"Kit or Assembled"

G)

H)

Now — convert your tube-type Heathkit VTVM to instant-on solid-state design



This new kit replaces the 6AL5 and 12AU7 tubes used in many Heathkit VTVMs, including current models IM-18 and IM-28. The two solid-state devices plug directly into the tube sockets. One device is a high voltage amplifier containing 4 FETs; the other contains 2 special diodes with low forward drop. The result is instant-on service — no more waiting for tubes to warm up — and no more pointer-drift corrections. Move your VTVM into the solid-state age today.

IMA-18-1, 1 lb., mailable **16.95**

Heathkit products are the result of a quarter-century of kit engineering experience

for better performance, better value

A) Heathkit 40 kV Probe Meter

TV tube voltage measurements are fast and convenient with the new Heathkit IM-5210 Probe Meter. It is light weight, portable and will measure DC voltages up to 40 kV with ±3% accuracy. You just attach the ground clip to the TV chassis, place the probe against the tube's high voltage connector and switch on the meter—it's as simple as that. The on-off switch on the handle protects the meter during hookup and when the probe is not in use. The IM-5210 is an easy kit to build, taking about an hour to assemble and is the best high voltage measurement value on the market.

Kit IM-5210, 2 lbs., mailable **17.95**

Assembled SM-5210, factory wired version of the IM-5210, 2 lbs., mailable ..... **Was 24.95, Now Only 19.95**

IM-5210 SPECIFICATIONS — Voltage Range: 0-40 kVDC. **Accuracy:** ±3% of full scale. **Size:** 1½" H x 1⅞" W x 15" D.

B) Heathkit taut-band general-purpose VOM

It's an easy, enjoyable one-evening kit—build-up two modular circuit boards and you have it. This highly versatile IM-105 gives you a low-friction, taut-band meter with diode & fuse protected movement that can suffer years of rough treatment and bounce back for more. Fuse in-line with the input connector is removable from front for extra convenience. Other professional features include calibrating controls, DC polarity switch, self-storing handle.

Kit IM-105, 3 lbs., mailable **64.95**

Assembled SM-660, (less 5 KV ranges), 4 lbs., mailable **72.00**

IM-105 SPECIFICATIONS — DC VOLTAGE RANGES: −0.25, 2.5, 10, 50, 250, 500, 1000 & 5000 V full scale. **Accuracy:** ±3% of full scale. **Input resistance:** 20,000 ohms/V full scale. **AC VOLTAGE RANGES:** −2.5, 10, 50, 250, 500 V 1 kV & 5 kV full scale. **Accuracy:** ±4% of full scale. **Input resistance:** 5000 ohms/V. **Input capacity:** Less than 20 pF. **Frequency response:** 2.5, 10, and 50 V ranges: ±5%, 10 Hz to 100 kHz; 250, 500 V ranges: ±5%, 10 Hz. **DC CURRENT RANGES:** −0.05, 1.0, 10, 100, 500 mA & 10 A full scale. **Accuracy:** ±3% of full scale. **Voltage drop:** Approximately 0.25 V at full scale. **RESISTANCE RANGES:** −x1 (20 center scale), x10, x100, x1k, x10k. **Accuracy:** ±3 degrees of arc. **Source voltage:** x1 through x1k range: 1.5 V x 10k range: 15 V. **DECIBEL RANGES:** (0 dB = 1 mW in 600 ohms): −10 to +56 dB. **GENERAL — Voltage dividers** −1% metal film resistors on most ranges. **Meter:** 4½", 50 μA, ruggedized, taut-band movement. **Meter protection:** Combined fuse and diode overload protection. **Meter temperature coefficient:** 15 to 35° C, ±1% (or 0.1 degree of arc) per degree C. **Operating temperature range:** 0-55° C. **Batteries (not supplied):** One 1.5 V "D" cell (NEDA #13). One 15V (NEDA #208). **Dimensions:** 7" H x 5" W x 2¼" D. **Test Leads:** Supplied.

C) Heathkit FET taut-band VOM—ten megohm input in a portable meter

A portable lab-grade FET VOM combining accuracy, versatility, convenience and ruggedness—in an easy-to-build dollar-saving kit! Our IM-104 has low-drift 1% precision metal film and wirewound resistors for exceptional stability. Nine DCV & ACV ranges measure from .01V to 1000V. Six current ranges cover 0.001 mA to 1000mA, DC & AC. Seven resistance ranges from 1 ohm to 100 megohms, conventional or low voltage modes. Decibel ranges from −40 dB to +62 dB. DC null scale with better than 1 mV resolution. The 4½" ruggedized, taut-band meter is diode protected, built to take plenty of abuse. Built-in circuitry shows battery condition at the flip of the range selector. Three evenings put this great portable VOM on your bench.

Kit IM-104, 4 lbs., mailable **94.95**

Assembled SM-666, has additional 1μA current range, less 100 & 1000 mA ranges, 4 lbs., mailable **149.00**

IM-104 SPECIFICATIONS — DC VOLTMETER — 9 ranges: 0.1, 0.3, 1, 3, 10, 30, 100, 300, 1000V. **Input resistance:** 10 megohm. **Accuracy:** ±2% of full scale (meter in horizontal position). **AC rejection:** Accuracy not affected by impressed 60 Hz sine wave with rms value 2x greater than full-scale value. **Null indicator:** On 0.1, 1, 10, 100, 1000V, meter zero level may be adjusted to center of null referenced scale. Null variations of approx. 1% of full-scale can be resolved. **AC VOLTMETER — 9 ranges:** 0-0.1, 0.3, 1, 3, 10, 30, 100, 300, 1000V. **Range factor:** 1 to 3.162 (10 dB) per step. **Input resistance:** 10 megohm. **Input capacity:** 100 pF typical. **Accuracy:** ±3% of full scale (meter in horizontal position; 60 Hz sine wave). **Response:** Average value of ½ sine wave. Scale calibrated to indicate rms. **Frequency response:** 20 Hz to 20 kHz ±3%, 20 Hz to 50 kHz ±5% on 0.1 to 30 V, 20 Hz to 10 kHz ±3%, 20 Hz to 20 kHz ±5% on 100 and 300 V. 20 Hz to 1.0 kHz ±3%, 20 Hz to 2.5 kHz ±5% on 1000 V. **DC MILLIAMMETER — 6 ranges:** 0-0.01, .1, 1, 10, 100, 1000V mA. **Voltage drop (approx. full scale):** 0.100 V on 0.01 to 10, 0.150V on 100, 0.350 V on 1000. **Insertion resistance:** Voltage drop divided by full-scale current. **Accuracy:** ±2% on 0.01 to 100, ±3% on 1000. (Meter in horizontal position). **AC MILLIAMMETER — 6 ranges:** 0-0.01, 0.1, 1, 10, 100, 1000 mA. **Voltage drop (approx. of full scale):** 0.100 V on 0.01 to 1, 0.150 V on 100, 0.350 on 1000 V. **Insertion resistance:** Voltage drop divided by full scale. **Accuracy:** ±3° on 0.01 to 100, ±4% on 1000. (Meter in horizontal position; 60 Hz sine waves). **Response:** Average value of ½ of sine wave (DC current must be negligible). Scale calibrated to include rms. **Frequency response:** 20 Hz to 5 kHz ±3% on 0.01, 20 Hz to 20 kHz ±3% on 0.1, 20 Hz to 50 kHz ±3% on 1 to 1000. **OHMMETER — 7 ranges:** Rx1 (10 ohm center scale), Rx10, Rx100, Rx1k, Rx10k, Rx100k, Rx1M. **Accuracy:** ±3% on x10 to 1M. **Test voltage (nominal):** 1.55V on +DC/ohm and −DC/ohm, 0.085 V on ohm. **DB RANGE — 9 ranges (0 db=mV into 600 ohm):** −40 to −18, −30 to −8, −20 to +2, −10 to +12, 0 +22, +10 to +32, +20 to +42, +30 to +52, +40 to +62. **Accuracy:** ±3 db @ −20 dB to ±0.3 dB @ +28. **Voltage dividers:** 1% precision metal-film resistors. **Meter:** 4½", 100 μA, 95° ruggedized, taut-band movement. **Meter protection:** will sustain momentary overload of 220 VAC or DC on any range, diode and 2A fuse protected on ohms x1 and 0.01 to 100 mA, FET protected on 0.1 to 100 V and ohms x10k to ohms x1M. Internal circuitry protected against improper battery installation. Diode protected meter. **Amplified circuit:** Dual FET source followers driving operational amp. **Front panel switches:** 24-position, continuous rotation RANGE switch (including battery check position BATT and OFF). 4-position pushbutton switch for AC, ohm LV, −DC/ohm, +DC/ohm. **Meter temperature coefficient:** Maximum of ±0.2% or ±0.2° or arc per °C over range of 15 to 35°C. **Operating temperature:** 0 to 50°C. **Storage temperature (less batteries):** −40 to +80°C. **Batteries (not supplied):** 1 1.5 V D-cell (NEDA #13). 4 1.5 AA-cell (NEDA #15). **Dimensions:** 6.95" H x 4.95" W x 2.25" D.

D) Heathkit IM-18—our most popular VTVM

For decades, Heathkit VTVMs have been prized by owners for their convenient size, practical meter ranges, single test probe, and low cost. The IM-18 possesses all of these traditional Heathkit values, plus impressive features of its own: a single probe for all measurements—seven AC, seven DC, and seven Ohms ranges; precision 4½" 200 μA meter; 1% precision divider network resistors; ±1 dB 25 Hz to 1 MHz frequency response; rms & p-p AC voltage measurements; circuit board design for fast, easy assembly; 120/240 VAC wiring options.

Kit IM-18, 5 lbs., mailable **36.95**

Assembled SM-20A, 6 lbs., mailable **70.00**

IM-18 SPECIFICATIONS — Meter scales: DC & AC (rms): 0-1.5, 15, 50, 150, 500, 1500 V full scale. **AC peak-to-peak:** 0.4, 14, 40, 140, 400, 1400, 4000 V full scale. **Resistance:** 10 ohm center scale x1, x10, x100, x1000, x10k, x100k, x1 meg. Measures 1 ohm to 100 megohms. **Meter:** 4½" 200 μA movement. **Input resistance:** 11 megohms (1 megohm in probe) on all DC ranges; 1 megohm shunted by 35 pF on all AC ranges. **Circuit:** Balanced bridge (push-pull) using twin triode. **Accuracy:** DC ±3%, AC ±5% of full scale. **Frequency response:** ±1 dB, 25 Hz to MHz (600 ohm source). **Tubes:** 12AU7, 6AL5. **Battery requirements:** 1.5 V, size "C" cell (not supplied). **Power requirements:** 120/240 VAC, 50/60 Hz. 10 W. **Dimensions:** 7⅜" H x 4½" W x 4¼" D.

E) Heathkit IM-28 Service Bench VTVM

A deluxe version of the IM-18 in a big stay-put size for your bench and a big easy-to-read 6" meter.

Kit IM-28, 7 lbs., mailable **46.95**

Assembled SM-21A, 7 lbs., mailable **90.00**

IM-28 SPECIFICATIONS — DC VOLTMETER — Ranges: 0-1.5, 5, 15, 50, 150, 500, 1500 V full scale; up to 30,000 V with accessory probe. **Input Resistance:** 11 megohm (1 megohm in probe) on all ranges: 1100 megohms with accessory probe. **Circuit:** Balanced bridge (push-pull) using twin triode. **Accuracy:** ±3% of full scale. **AC VOLTMETER — Ranges:** 0-1.5, 5, 15, 50, 150, 500, 1500 rms scales (.353 of peak-to-peak). **Frequency Response (5 V range):** ±1 dB 25 Hz to 1 MHz (600 ohm source, referred to 60 Hz). **Circuit:** Halfwave voltage doubler, using twin diode. **Accuracy:** 5% of full scale. **Input Resistance & Capacitance:** 1 megohm shunted by 40 pF measured at input terminals (200 pF at probe tip). **OHM-METER — Ranges:** Scale with 10 ohm center X1, X10, X100, X1000, X10k, X100k, X1 meg. Measures .1 ohm to 1000 megohms with internal battery. **Meter:** 6" 200 μA movement, polystyrene case. **Probe:** Combined AC-OHMS-DC switching probe, single jack input for probe and ground connections. **Dividers:** 1% precision type. **Battery:** 1½ V, "C" cell (not supplied). **Power Requirements:** 120/240 VAC, 50/60 Hz, 10 W. **Dimensions:** 5" H x 12⅛" W x 4¾" D.

F) Heathkit Laboratory AC VTVM

The IM-38 features extended accuracy in measuring low-level AC voltages. Any voltage from 10 Hz to 1 MHz can be measured quickly. It can also be used as a VU meter to indicate changing AC voltages, such as those that occur in speech or music equipment.

Kit IM-38, 5 lbs., mailable **52.50**

Assembled SM-22A, 6 lbs., mailable **85.00**

IM-38 SPECIFICATIONS — Frequency response: ±1 dB 10 Hz to 500 kHz. ±2 dB 10 Hz to 1 MHz, all ranges. **Ranges:** Ten ranges from 0.01 to 300 V rms full scale. **Decibels:** Total-range −52 to +58, meter scale −12 to +2 dB (0 dB = 1 mW in 600 ohms), ten switch selected ranges from −40 dB to +50 dB in 10 dB steps. **Input impedance:** 10 megohms shunted by 12 pF on ranges 10 to 300 V, scale. 10 megohms shunted by 22 pF on ranges .01 to 3 V. **Accuracy:** Within 5% of full scale. **Power requirements:** 120/250 VAC, 50/60 Hz, 10 W. **Dimensions:** 7⅜" H x 4½" W x 4⅛" D.

G) Heathkit IM-17—everyman's VOM

The perfect buy for homeowners, hams, servicemen, hobbyists, modelers—everyone. All solid-state with FET input for less circuit loading, better accuracy than ordinary VOMs. Features include portable battery operation, zero and ohms adjust controls, accessory probe jack. DC polarity reversing switch, three built-in test leads, easy 3-5 hour assembly.

Kit IM-17, 4 lbs., mailable **29.95**

IM-17 SPECIFICATIONS — DC VOLTMETER — Four ranges: 0-1, 10, 100, 1000 V full scales. **Input resistance:** 11 meg. on all ranges. **Accuracy:** ±3% of full scale. **AC VOLTMETER — Four ranges:** 0-1, 10, 100, 1000V full scale. **Input resistance:** 1 meg. on all ranges. **Accuracy:** ±5% of full scale. **Frequency response:** ±1 dB, 10 Hz to 1 MHz. **OHMMETER — Four ranges:** RX1, RX100, RX10k, RX1M. **Input resistance:** 1 meg. on all ranges. **Amplifier circuit:** 8.4 V mercury cell (NEDA #1611), batteries not supplied. **GENERAL — Meter:** 4½", 200 μA, 100° movement. **Dimensions:** 5⅜" H x 9⅜" W x 9" D.

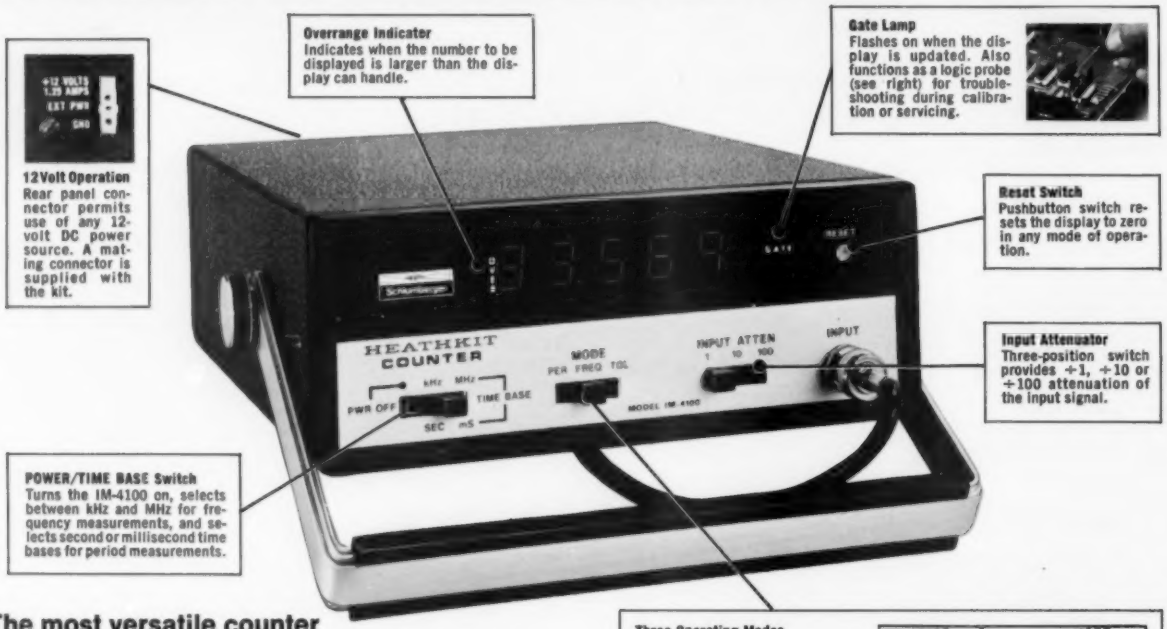
H) Heathkit Line Voltage Monitor

The ideal accessory for labs, shops, hams & CBer's, hobbyists. Improper line voltage can cause poor operation of test equipment and circuits. With the solid-state IM-103, you always know what your line voltage is. When calibrated from a source of known accuracy, the IM-103 has an accuracy of ±2%. The large, expanded scale meter lets you know at a glance what your power line voltage is.

Kit IM-103, 3 lbs., mailable **19.95**

IM-103 SPECIFICATONS — Voltage range: 90 VAC (rms) — 140 VAC (rms). **Voltage accuracy (sine wave):** ±2% when calibrated with a known line voltage. **Power requirements:** 90-140 VAC, 50-60 Hz, 4.2 W. **Dimensions:** 5⅛" H x 6¼" W x 3" D.

New Multi-function Counter – only $129.95


12 Volt Operation
Rear panel connector permits use of any 12-volt DC power source. A mating connector is supplied with the kit.
Overrange Indicater
Indicates when the number to be displayed is larger than the display can handle.
Gate Lamp
Flashes on when the display is updated. Also functions as a logic probe (see right) for troubleshooting during calibration or servicing.
Reset Switch
Pushbutton switch resets the display to zero in any mode of operation.
Input Attenuator
Three-position switch provides ÷1, ÷10 or ÷100 attenuation of the input signal.
POWER/TIME BASE Switch
Turns the IM-4100 on, selects between kHz and MHz for frequency measurements, and selects second or millisecond time bases for period measurements.
HEATHKIT
COUNTER
MODEL IM-4100
INPUT ATTEN
INPUT
MODE
PER FREQ TOL
TIME BASE
PWR OFF
kHz MHz
SEC mS

The most versatile counter we've ever offered... displays frequency to 30 MHz, period to 99.999 seconds, counts events to 99,999... all for only 129.95!

The new Heathkit IM-4100 is an almost unbelievable counter value. It's a full five-digit frequency counter, it will also function in period mode or totalize mode. It provides built-in input attenuation and 12-volt operation all in one compact package.

As a frequency counter, the IM-4100 is guaranteed to 30 MHz with 1 Hz resolution. Sensitivity is a low 15 mV from 50 Hz to 30 MHz, 50 mV below 50 Hz.

In the period mode, it measures intervals up to 99.999 seconds. Using the millisecond time base, it resolves to 1 msec! This mode can be used for low frequency measurements with high accuracy. Just position the TIME BASE switch to mS and the MODE switch to PER. Then solve the equation f = 1/period, using the displayed value.

The totalize mode will add up (totalize) event pulses up to a count of 99,999. Pushing the RESET button starts the count at zero. An inhibit signal can be applied through a rear panel terminal to stop the totalize mode at any time, without loss of the displayed count.

The front panel attenuator switch allows the amplitude of input signals to be divided by 1, 10 or 100. The pushbutton RESET switch quickly resets the display to zero in *any* mode. Front panel display includes overrange indicator and a gate lamp.

A rear panel switch easily selects internal or external time base. The rear panel connector can be used as an input for the external time base signal, or as an output to check the internal 10 MHz time base or provide a convenient frequency standard of 1 MHz for bench use.

Operation from any 12-volt DC source is possible with the IM-4100 — no extra accessories are needed. Power is applied through a rear panel connector (mating connector supplied).

And the IM-4100 is easy to build thanks to the open circuit board layout. A simple gate light modification gives you a handy logic probe for trouble-shooting should problems arise.

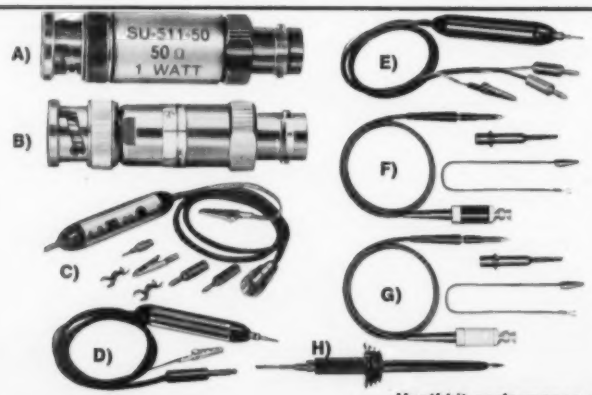
It's a great instrument value at an almost-too-good-to-be-true price.

Three Operating Modes
Modes for frequency measurement to 30 MHz, period measurements to 99.999 seconds, or totalize for events counting to 99,999 are easily switch-selected.

Measure frequency... or period.

Kit IM-4100, 7 lbs., mailable **129.95**

IM-4100 SPECIFICATIONS — FUNCTIONS — Frequency: 5 Hz to 30 MHz. **Period:** 1 μsec resolution to 99.999 sec. **Totalize:** 1-99,999 events. **INPUT — Frequency Range:** 5 Hz to 30 MHz minimum. **Sensitivity:** 15 mV rms (50 mV, 5 Hz to 50 Hz). **Period Pulse Width:** 25 nsec minimum. **Low Frequency Signal Risetime:** 1 msec for signals less than 10 Hz. **Input Impedance:** 1 megohm shunted by less than 35 pF. **Protection:** 240 volts rms at 60 Hz. **Attenuator:** X1, X10, X100 fixed compensation. **TIME BASE — Frequency:** 10 MHz. **Setability:** ±1 ppm. **Temperature Stability:** ±10 ppm, maximum 0° to 40° ambient. **OSCILLATOR CONNECTION — External Input Frequency:** DC to 20 MHz. **External Input Sensitivity:** TTL or 2.5 V rms from 50-ohm source. **Internal Output:** TTL signal at 1 MHz. **GENERAL — Gate Interval:** kHz-1 sec, MHz-1 msec (indicated by gate light). **Manual Gate:** DC control in events mode using external OSC input connector. **Display Time:** 200 msec plus gate interval. **Power Requirements:** 105-130 or 210-260 VAC (switch selected), 50/60 Hz, (at 25 watts.); or 9-14 VDC at 1.25 amperes. **Dimensions:** 2¾" H x 7¼" W x 10½" D (less handle).



Probes & accessories for Heathkit instruments

A) 50-ohm Termination for frequency counters and scopes. DC to 1 GHz range; power rating is 1 watt. VSWR: 250 MHz, 1.2:1; 600 MHz, 2:1. **Assembled SU-511-50,** 1 lb., mailable **15.00**

B) RF Fuse in UHF BNC-to-BNC connector. Prevents accidental burnout of devices sensitive to RF power. DC to 500 MHz range; 50 ohms impedance; 12.1 VSWR (max.); insertion loss 1.80 dB max. at 500 MHz. Spare fuses included. **Assembled SU-512-50,** 1 lb., mailable .. **45.00**

C) Low capacitance scope probe provides direct or X10 attenuated operation; options for 3.3 or 1 megohm input resistance. **Kit PK-1,** 1 lb., mailable **5.95**

D) Etched circuit RF probe for RF measurements from 1000 Hz to over 100 MHz; 11 meg input; 1000 VDC max. at tip; 90 V rms max. **Kit PK-3,** 1 lb., mailable **5.95**
Assembled PKW-3, 1 lb., mailable **7.95**

E) Scope demodulator probe for distortion checks and display of RF & IF signal modulation. Functions as an AM detector, 30 V rms max.,

Heathkit performance specifications are guaranteed

Your counter dollar buys more at Heath

180 MHz Counter with phase-locked frequency multiplier...349.95

1 Hz to 180 MHz range...sensitivity of 50 mV to 120 MHz, 100 mV to 180 MHz. Pushbutton selection of x1, 10, 100 or 1000 multiplier permits resolution down to 0.001 Hz for signals up to 10 kHz.

TCXO (temperature compensated crystal oscillator) provides high stability and excellent aging characteristics, insuring its fundamental accuracy. Pushbutton selection of 1 msec, 100 msec and 1 second gate times allow variable resolution readings. Rear panel switch and input connection permit use of an external clock.

Features include 8-digit cold-cathode display plus range, overrange, gate and loop-unlocked indicators...separate AC and DC coupled inputs...120/240 VAC primary. You don't have to spend a fortune to get VHF counting capability...order your IB-1103 today.

Kit IB-1103, 12 lbs., mailable **349.95**

IB-1103 SPECIFICATIONS — FREQUENCY MEASUREMENTS — Range: 1 Hz to 180 MHz. **Gate time:** 1 msec., 100 msec., or 1 sec. **Accuracy:** ±1 count ±time base stability. **Readout:** MHz, kHz, or Hz with correctly positioned decimal. **SIGNAL INPUT — Maximum sensitivity:** 50 mV to 120 MHz, 100 mV to 180 MHz. **Coupling:** AC and DC (two separate inputs). **Impedance:** 1 megohm in parallel with 35 pF. **Trigger level:** Automatic. **Overload:** Diode-protected input circuit. **TIME BASE — Crystal frequency:** 4 MHz TCXO (Temperature Compensated Crystal Oscillator). **Stability:** Aging rate ±1 ppm/yr. Short term better than 0.5 ppm in 1 sec. Temperature ±1 ppm between 15° to 40°C. Line voltage 0.5 ppm with ±10% voltage change. **Frequency trimming:** Accuracy ±1 ppm. Range ±10 ppm. **Sample rate:** Approx. 500 msec. (time between two openings of counting gate). **FREQUENCY MULTIPLIER — Ranges versus input frequency:** x1: No multiplier (direct counting). x10: 100 Hz to 300 kHz. x100: 10 Hz to 100 kHz. x1000: 10 Hz to 10 kHz. **Accuracy:** x10: ±1 count ± time base accuracy. x100: ±1 count ± time base accuracy. x1000: At less than 500 Hz, ±1 count ± time base stability. At greater than 500 Hz, ±2 counts ± time base stability. **To remain locked:** Frequency rate of change must not exceed 10 Hz. **Lock time after step frequency change:** x10 & x100: 5 sec. for frequencies less than 500 Hz; 3 sec. for frequencies greater than 500 Hz. x1000: 1.5 sec. for frequencies less than 500 Hz; 1 sec. for frequencies greater than 500 Hz. **Lock indicator:** Front panel lamp; "Off" = locked, "On" = unlocked. **EXTERNAL TIME BASE INPUT — Frequency:** 1 MHz with stability greater than 10^{-7}. **Input impedance:** 1000 ohms. **Maximum input:** 3 V rms. **GENERAL — Display:** 8½ digits plus overrange, gate, MHz, kHz, Hz and unlocked lamps. **Operating temperature range:** Operating 10°C to 40°C. **Power requirements:** 120/240 VAC, 50/60 Hz, 40 W when not using frequency multiplier, 45 W when using frequency multiplier. **Connectors:** 3 BNCs. Input (AC & DC) on front panel; external clock on rear panel. **Dimensions:** 3⅝" H x 8⅝" W x 9¼" D.

8-digit, 120 MHz Counter...279.95

120 MHz range...excellent sensitivity...high stability...low cost: that's the Heath IB-1102. 50 mV sensitivity over the entire range. FET input circuitry offers high impedance for minimum circuit loading...automatic triggering level. The high stability 4 MHz temperature compensated crystal oscillator provides unusual accuracy for a counter in this price class...for even more critical measurements you can use an external time base. Eight-digit, cold-cathode readout plus lighted indicators for MHz, kHz, overrange and gate condition mean resolution down to 1 Hz for frequencies up to 99.999 MHz... 10 Hz resolution for frequencies over 100 MHz.

Kit IB-1102, 12 lbs., mailable **279.95**

IB-1102 SPECIFICATIONS — FREQUENCY MEASUREMENTS — Range: 1 Hz to 120 MHz. **Gate time:** 1 msec. or 1 sec. **Accuracy:** ±1 count ± time base stability. **Readout:** kHz or MHz with fixed decimal point. **SIGNAL INPUT — Sensitivity:** 50 mV rms. **Impedance:** 1 megohm in parallel with 35 pF. **Trigger level:** Automatic. **Overload:** Diode protected input circuit. **TIME BASE — Crystal Frequency:** 4 MHz, TCXO (Temperature Compensated Crystal Oscillator). **Stability: Aging rate:** ±1 ppm/yr. **Short term:** Better than 0.5 ppm in 1 sec. **Temperature:** ±1 ppm between 15°C to 50°C. **Line voltage:** 0.5 ppm with ±10% voltage change. **Frequency trimming: Accuracy:** ±1 ppm. **Range:** ±10 ppm. **Sample rate:** 500 msec. (Time between two openings of counting gate). **EXTERNAL TIME BASE INPUT: Frequency:** 1 MHz with stability $>10^{-7}$. **Input impedance:** 1000Ω. **Maximum input:** 3V rms. **GENERAL — Display:** 8 digits plus overrange, gate, kHz, and MHz lamps. **Operating temperature range:** Operating 10°C to 40°C. **Power requirements:** 120/220 VAC, 50/60 Hz, 30 W. **Connectors:** Two BNC's. Input on front panel; external clock on rear panel. **Cabinet dimensions:** 8⅝" W x 3⅜" H x 9¼" D.

500 VDC max. **Kit 337-C,** 1 lb., mailable **5.00**

F) High frequency compensated scope probe features DC-60 MHz bandwidth; 10 megohm/11.5 pF input impedance; compensation for any 1 megohm/15-40 pF scope input; X10 attenuation; 500 V AC & DC rating. Ideal for use with IO-104, IO-4510 and IO-4530 scopes. **Assembled PKW-101,** 1 lb., mailable **26.95**

PKA-101-1 Accessory Pack...consists of the most commonly lost or damaged parts of the PKW-101. Includes three assembled tips, two 6-inch ground leads and one 12-inch ground lead. **PKA-101-1,** 2 lbs., mailable **9.95**

G) Direct (X1) scope probe is useful with scopes, frequency counters or whenever you are checking waveforms and levels in any low impedance circuit. 1 megohm/30 pF input impedance. 600 V AC & DC rating. Range 17 MHz typical. Rise time 17 nsec. typical. BNC connector. **Assembled PKW-104,** 2 lbs., mailable **21.95**

H) 30 kV High Voltage Probes...IMA-100-10 Probe multiplies DC ranges of any 10-megohm meter by factor of 100. 1000 megohm input for measuring voltages as low as 1 V in high-impedance circuits. Banana plug connector. **Kit IMA-100-10,** 2 lbs., mailable **10.95**

IMA-100-11 Probe provides X100 measurement capability for meters with 11-megohm input impedance. Phone plug connector with alligator ground clip. Available kit or assembled. **Kit IMA-100-11,** 2 lbs., mailable **10.95**

Assembled SMA-100-11, 2 lbs., mailable **13.95**

IMA-1000-1 Probe provides X1000 attenuation for meters with 1-megohm input impedance. Banana plug connector. **Kit IMA-1000-1,** 2 lbs., mailable **10.95**

Accessory cables...for inter-connecting instruments such as scopes, counters, etc. All cable is RG-58A/U, 50 ohm impedance.

Assembled SU-501-1, 1 lb., BNC/BNC, 1 lb. **7.50**

Assembled SU-501-3, 3 ft., BNC/BNC, 1 lb. **7.50**

Assembled SU-501-6, 6 ft., BNC/BNC, 1 lb. **7.50**

Assembled SU-502-3, 3 ft., BNC/UHF, 1 lb. **7.50**

Assembled SU-503-3, 3 ft., BNC/Banana, 1 lb. **7.50**

Our famous GR-2000

The Heath GR-2000 25 in. (diagonal) Digital Design Color TV

It silently selects channels with digital-logic accuracy—it displays the channel digits on the screen—it displays the time digits on the screen—it uses a fixed filter IF that never needs alignment— it uses more integrated circuitry than any other set. Yet the kit-building process is easier than ever.

Silent, All-Electronic Touch-Tuning—no knobs to turn, no noisy turrets, no humming motors and no mechanical contacts to clean. Now you just touch a button on the front panel or optional remote control transmitter and the programmable Digital Counter silently sweeps up or down through any 16 preselected station. Release the button and the new UHF/VHF Varactor Tuner is precisely locked-in on the channel of your choice.

You program up to 16 channels into the Touch-Tune System located in the convenient slide-out service drawer. You can program any channels in any sequence, interspersing UHF with VHF, even programming the same channel to appear more than once if you like.

The channel number is seen on the screen—The Heath-designed On-Screen Electronic Digital Channel Readout has bright white numerals that are easy to see—from across the room, from any viewing angle. Each time you change channels, using the Touch-Tune button either on the set or on the remote control, illuminated digits (adjustable brightness) identify the UHF and VHF stations as you cycle through the channels. After stopping at a desired program, the readout remains on for as long as you want, up to 1½ minutes, or stays on all the time...the choice is yours. And you can position the digital readout anyplace on the screen, too.

We even changed the way you adjust the sound—With the optional remote control installed, a touch of either of two buttons on the set or the remote automatically raises or lowers the sound in a series of small steps. Just hold the button down until the sound level is right where you want it. This also controls the volume of the Hi-Fi Sound Output (to your separate amplifier) so you can control it with your remote transmitter.

Build-in an optional Electronic Clock with Digital On-screen Readout—true digital circuitry gives you the time in four-digit, six digit, 12-hour or 24-hour format. A programming board in the slide-out service drawer lets you set your clock to display time the way you want to see it. The on-screen display appears directly below the channel numeral in same-size 1" digits. And when you add the clock option, it becomes an integral part of the channel display, responding to the same controls. It can be positioned anywhere on the screen with the channel digits, remains on for the same pre-set length of time, or remains on constantly.

A Heath-designed IF Filter sets this TV apart from all others—For truly superior color reception, particularly in urban areas where multiple transmitters are located or where multi-channel cable service is available, we designed a fixed LC-type filter with an IC IF amplifier into the GR-2000...a "first" in the television industry. This unique circuitry produces an ideally shaped bandpass that greatly reduces adjacent-channel interference. And, this totally new approach to IF design gives the GR-2000 another equally important plus—a consistently excellent color picture, year after year with no need for periodic instrument alignment. The GR-2000 IF system eliminates the highly critical traps that go out of adjustment because of normal component value changes through aging. In short, the Heathkit GR-2000 will maintain its best picture longer than any set with ordinary IF design.

Add Total Touch-Tune Remote Control—it's an all solid-state ultrasonic system that lets you select UHF/VHF channels, control volume, color tint and intensity, on and off. And you do so from as far as 20 feet from the set. The channel selector and volume buttons on the remote also may be used to return the channel and clock readouts to the picture screen whenever you wish.

The easiest-to-build color TV we've ever offered—The GR-2000 100% solid-state chassis has 19 ICs, including custom MOS designs, plus another 13 ICs with the remote control and yet another IC if you add the clock. DC controlled contrast for less picture interference. IC color amplifier for truer colors. IC color oscillator and automatic phase control for more precise and reliable tints. IC automatic gain control for improved sensitivity, stability and noise immunity. Improved picture interlace for remarkable image definition and crispness. For all this, the actual assembly operations for this kit have been greatly simplified. The GR-2000 has fewer point-to-point connections, more ICs, more modular circuit boards, more prefabricated wiring harnesses and cables, and fewer chassis-mounted parts to make it easier to build.

New, latest-design picture tube—a deluxe Black (Negative) Matrix 25V picture tube now with fully illuminated dots and black "surround"...it all adds up to greater contrast and a bright, vivid picture that's one of the finest in the world.

New exclusive Heath self-service features—no other manufacturer offers them to you at any price. Built-in service facilities such as a new digital-design true dot generator, purity and convergence adjustments; test meter; new vertical and horizontal centering circuits; new Top-Bottom-Sides pincushioning corrections; new "Service" circuit board puts everything in an easy-to-find place.

We set out to design the most advanced and unique color TV available today...we believe the performance of the set speaks for itself. The digital-design Heathkit GR-2000...it will change your mind about color TV.

Kit GR-2000, chassis, tube, 1 speaker (less cabinet), 147 lbs., Exp./Frt. **689.95**

Kit GRA-2000-6, Remote Control, 4 lbs., mailable **89.95**

Kit GRA-2000-1, Digital Clock Accessory, 1 lb., mailable **29.95**

GRA-2000-7, second speaker for GR-2000, fits space provided in all GR-2000 cabinets, includes all necessary connecting cables, 3 lbs., mailable **6.50**

GR-2000 SPECIFICATIONS — Picture tube: 25" (diagonal). **Viewing area:** 315 sq. in. **Deflection:** Magnetic, 90 degrees. **Focus:** Electrostatic. **Convergence:** Magnetic. **Antenna input impedance: VHF:** 300 Ω balanced or 75 Ω unbalanced. **UHF:** 300 Ω balanced. **Tuning range:** TV channels 2 through 83. (Preset any 16). **Picture IF carrier:** 45.75 MHz. **Sound IF carrier:** 41.25 MHz. **Color IF subcarrier:** 42.17 MHz. **Sound IF carrier:** 41.25 MHz. **Color IF subcarrier:** 42.17 MHz. **Sound IF frequency:** 4.5 MHz. **Video IF bandwidth:** 4.08 MHz, at 6 dB down. **Hi-Fi output: Output impedance:** 2200 Ω. **Frequency response:** ±1 dB, 50 Hz to 15 kHz. **Harmonic distortion:** Less than 1% at 1 kHz. **Output voltage:** greater than 1.0V rms. **Audio output: Output impedance:** 4 Ω or 8 Ω. **Output power:** 2 watts. **Power requirements:** 110 to 130 volts AC, 60 Hz, 200 watts. **Net weight:** 112 lbs.

Expedited 48-Hour No-Charge Warranty Service Plan for Solid-State TV Modules!
Special service facilities have been established at the factory and all Heathkit Electronic Centers to expedite service and return of Solid-State TV circuit modules within two working days (plus transportation time). If a component proves defective during the 90-day warranty period, the modules will be serviced with no charge for parts or labor. If the problem is due to a construction error or if the 90-day warranty has expired, modules will be serviced at a fixed charge of $5.00 per module. All picture tubes warranted for two full years.

Optional Digital Clock

Gives you on-screen readout of the time directly below the channel number readout when the set is "on". Clock circuit board has jumper wire for selecting 12 or 24-hour format. You set your on-screen display for hours and minutes, or hours, minutes and seconds. Order with your GR-2000, or add it later.

Kit GRA-2000-1, Digital Clock Accessory, 1 lb., mailable **29.95**

Ultrasonic Remote Control

Gives you wireless armchair control of on and off, volume, VHF/UHF channel selection, up or down color intensity, and tint. Plus, a touch of the volume button automatically recalls the digital readout to the screen. Kit includes receiver for in-chassis mounting and hand-held transmitter. Operates from 20-feet away from set.

Kit GRA-2000-6, 4 lbs., mailable **89.95**

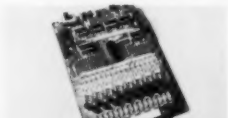
All TV picture tubes are warranted for 2 full years.

25V digital color TV

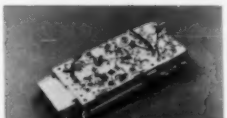
Simulated TV Pictures

Compact Contemporary Cabinet
Houses your GR-2000 in contemporary elegance even where space is limited. Like all Heath cabinets, it's solidly constructed of wood solids and veneers finished in luxurious oiled walnut stain. Comes fully assembled with cutout for one speaker. Measures 34⅜" H x 33⅞" W x 20⅜" D (24⅛" D including cup).
GRA-2000-8, 60 lbs., Exp./Frt. **129.95**

Only the Heathkit GR-2000 offers you all of these features:



Programmable Channel Selection through digital up-down counter with computer-like programming board — a breakthrough in new tuning convenience.

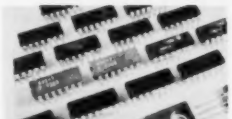


Silent All-Electronic Tuning with new combination UHF/VHF Varactor Tuner located inside the chassis where it is completely shielded.

On-Screen Channel Readout in big, bright numerals, with adjustable brightness — easily viewable from across the room at any viewing angle.

On-Screen Clock Readout — gives you the correct time in four or six-digit format, and with your choice of 12 or 24 hour time.

Fixed Filter IF totally eliminates instrument IF alignment forever — gives ideally shaped bandpass to eliminate critical traps and interference — another Heath exclusive.



19 Integrated Circuits (ICs) simplify kit building and permit ultra-sophisticated technology with long term reliability.

Finished cabinets for your GR-2000

Mediterranean cabinet with doors
Handsome, simulated wood-grain bi-fold doors turn this Mediterranean model into a magnificent piece of furniture in its own right. Open them for a panoramic view of your superb GR-2000 picture. Constructed of select solids and veneers with simulated wood-grain base and trim. Finished in rich dark oak stain. Metal hardware is finished in Windsor Antique Gold tone. Shipped fully assembled and finished and accepts a second speaker for full-width sound reproduction. Measures 29¾" H x 48⅛" W x 23" D. (26⅛" D including cup).
GRA-2000-5, 126 lbs., Exp./Frt. **219.95**

Mediterranean cabinet
Luxurious Mediterranean styling that serves as a suitably subtle back-drop for your brilliant GR-2000 color picture. Designed to accept two matching speakers for surrounding sound. Crafted of furniture-grade solids and veneers with simulated wood-grain trim. Finished in lovely dark oak stain. Metal hardware features Antique Gold finish. Shipped fully assembled and finished. Measures 30½" H x 49¾" W x 20⅞" D. (23¾" D including cup).
GRA-2000-4, 92 lbs., Exp./Frt. **169.95**

Contemporary cabinet
Here's contemporary styling at its finest — a fitting format for the world's most advanced color TV set. Has dual speaker capability that lets you place sound on both sides of the screen. Comes completely assembled and finished. Carefully constructed of select solids and veneers with oiled walnut stain. Measures 28⅜" H x 46¾" W x 20¾" D. (23⅜" D including cup).
GRA-2000-2, 89 lbs., Exp./Frt. **159.95**

Early American cabinet
An exciting contrast — traditional Early American design to house the world's most advanced color TV. Features twin speaker capability that gives you the option of room-filling sound. Constructed of distressed maple stained wood solids and veneers accented by simulated wood-grain trim. Hardware is metal with Windsor Antique Gold finish. Shipped fully assembled and finished. Measures 31¾" H x 47⅞" W x 20½" D. (23¾" D including cup).
GRA-2000-3, 94 lbs., Exp./Frt. **169.95**

Heathkit Digital Time and Weather

A) NEW Digital Electronic Wind Speed and Direction Indicator... just 69.95

Easy to build. Most parts mount on two circuit boards.

Choose two readout modes from mph, knots and kilometers per hour.

Our new ID-1590 is unique — a wind direction monitor and a highly accurate wind speed indicator with an easy-to-read digital display. It's perfect for pilots, boaters — anyone whose activities are affected by the wind.

A bright, two-digit, planar gas discharge readout displays the wind speed. During construction, you pick the two readout modes you need from three available modes: miles, knots or kilometers per hour. A rear panel switch chooses either of the two selected modes and front-panel lights show which mode is in use. A switch on the rear panel and two circuit board controls calibrate the ID-1590 for highly accurate readings. The wind direction indicator uses incandescent bulbs to mark the 8 principal compass points. Two adjacent bulbs can light at the same time to indicate an intermediate direction, providing 16-point resolution.

Installation is easy. The remote transmitter boom clamps onto any 1 to 1½" rooftop TV antenna mast and is connected to the receiver with optional cable. The rugged Cycolac® plastic case with teak-grain vinyl insert matches our GC-1005 Digital Clock and ID-1390 Digital Thermometer.

Kit ID-1590, 7 lbs., mailable **69.95**

IDA-1290-1, 50 ft. cable, 2 lbs., mailable **7.50**

IDA-1290-2, 100 ft. cable, 4 lbs., mailable **13.50**

IDA-1290-3, 150 ft. cable, 6 lbs., mailable **18.50**

ID-1590 SPECIFICATIONS — Wind Speed: 0-99 in miles per hour, knots or kilometers per hour (choice of two). **Response Threshold:** 3 mph. **Accuracy:** ±1 digit or ±10%, whichever is greater. **Direction Response Threshold:** approx. 2 mph. **Operating Temperature:** Remote transmitter, −40 to +120° F; Receiver, 0 to +150° F. **Power Requirement:** 120 VAC, 50/60 Hz, 6.5 watts. **Dimensions:** Receiver, 2½" H x 7" W x 5" D; Remote transmitter, 30" boom.

B) Indoor/Outdoor Digital Thermometer... 59.95

The ID-1390 monitors indoor/outdoor (or any two temperatures) with big, bright digital readout. A switch selects either Fahrenheit or Celsius readings. Another switch lets you choose continuous readings of one temperature or alternate readings of both. In the "alternate" mode, each temperature is displayed alternately for about 4 seconds. In "hold", a single temperature is monitored continuously with updated readings every 4 seconds. The large planar gas discharge readout includes plus and minus signs as well as indoor and outdoor indicator lights. The 85' of cable included with the sensors permits a variety of custom applications — home freezer, hot house, garage, basement, pump house, swimming pool, aquarium, almost any temperature. Black Cycolac® plastic case with teak-grain vinyl inserts matches the GC-1094 digital clock and ID-1590 digital wind speed/direction monitor.

Kit ID-1390, 5 lbs., mailable **59.95**

ID-1390 SPECIFICATIONS — Temperature Range: Fahrenheit −40 to +120°; Celsius −40 to +50°. **Accuracy:** Celsius, ±1°C from −15° to +50°C, ±2°C from −30° to −15°C. Fahrenheit, ±1°F from +20° to +120°F, ±2° from −30° to +20°F. **Power Requirement:** 110-130 VAC, 60 Hz, 4 to 6 watts approx. **Dimensions:** 2½" H x 7" W x 5" D.

C) Heathkit 5-in-1 Weather Station... 89.95

Indoor and outdoor temperatures, barometric pressure, wind speed and direction — all with electronic accuracy and reliability. The Uni/Mag barometer has 2½ times greater point deflection than conventional barometers so you can observe changes as small as 0.02 inches of mercury. The thermometer is calibrated in two degree increments from −40 to +120° F and a switch selects indoor or outdoor readings. The windspeed indicator has two ranges — 0-30 mph or 0-90 mph and 8 wind direction lights offer true 16-point resolution.

The ID-1290's walnut-grained plastic plaque can be hung vertically or horizontally and it can also be used as a desk set with the stands included with the kit. The remote transmitter assembly (windcups, weather vane and outdoor temperature sensor) clamps onto any TV antenna mast and is connected to the plaque with optional 8-wire cable (below). Includes comprehensive weather book.

Kit ID-1290, 9 lbs., mailable **89.95**

IDA-1290-1, 50 ft. cable, 2 lbs., mailable **7.50**

IDA-1290-2, 100 ft. cable, 4 lbs., mailable **13.50**

IDA-1290-3, 150 ft. cable, 6 lbs., mailable **18.50**

D) Budget-Priced Electronic Digital Alarm Clock...now just 49.95

The GC-1005 makes waking up a little easier. It wakes you to a gentle electronic "beep" and a switch on the back panel lets you take additional 7-minute catnaps, up to an hour. Another switch "holds" the time for easy, accurate setting. Should the power be interrupted for more than a few seconds, the display shows all "eights" until the clock is reset. An easy kit to build — most parts mount on two circuit boards. Can be wired for 12 or 24-hour readout.

Kit GC-1005, 4 lbs., mailable .... **Was 59.95 NOW 49.95**

GC-1005 SPECIFICATIONS — Accuracy: determined by line frequency. **Power Requirement:** 120/240 VAC, 60/50 Hz. **Dimensions:** 2½" H x 7" W x 4¾" D.

E) Save on our deluxe Digital Electronic Alarm Clock with standby battery power... just 79.95

You'll realize the GC-1092A is one of the world's finest timepieces the minute it wakes you with a gentle intermittent "beep." There are no switches or buttons to fumble for. Just touch the Heathkit "logo" on top of the case to turn off the alarm...electronically. If you activated the snooze cycle the night before, the GC-1092A will let you enjoy up to an hour of 7-minute catnaps. Even if the power is interrupted during the night, a built-in battery power supply keeps the alarm — and you — on time, without the display. When AC power is restored, the correct time will once again be displayed, no need to reset the clock. If you wire the GC-1092A for nickel-cadmium batteries, a built-in circuit keeps them at full charge.

Deluxe features, kit price — switch-selected 12 or 24-hour (military) time format; an AM indicator light lets you set the alarm for either 9 AM or 9 PM; an automatic light sensor dims the display in dark rooms so it won't keep you awake at night and a battery-saver switch disconnects the batteries when the clock is unplugged for extended periods. Hours, minutes and seconds are displayed on big, ½"-high 7-segment Beckman planar gas discharge tubes for easy visibility. A "hold" switch makes it easy to time intervals or set the clock. The handsome low-profile case in luxurious brown tones is compatible with any decor and sits atop a removable pedestal base which swivels for easy viewing from any angle. Plug-in ICs and color-coded wiring make it an enjoyable kitbuilding experience. Less batteries.

Kit GC-1092A, 5 lbs., mailable ... **Was 82.95 NOW 79.95**

F) Big savings on this deluxe Digital Electronic Calendar/Clock...now just 69.95*

In this unique timepiece, we swapped the alarm feature of the GC-1092A for the date—and held the same low kit price.

Instant time and date. The GC-1092D not only brings you the time in hours, minutes and seconds in bright orange ½"-high 7-segment Beckman planar gas discharge tube digits — it also automatically, or at a touch, brings you the date in four digits for the month and day. A switch selects 12 or 24-hour time format to suit your taste, and another switch lets you display time continuously or automatically display the date two seconds out of every ten. Or, simply touch the electronically-activated control on top of the case to call up the date display for approximately five seconds any time you want it.

Stand-by battery supply takes over instantly in case of a power interruption. It also features automatic control of display brightness — bright in brightly lit areas, dim in dimly lit areas — and a switch is provided for a continuously bright display if desired.

A "hold" switch on the bottom panel makes it easy to time intervals or set the clock. A battery-save switch position disconnects the battery when clock is unplugged. A built-in charging circuit keeps nickel-cadmium batteries at full charge or you can wire the GC-1092D for non-rechargeable standard batteries. Whether you use it at the office, in the ham shack, or around your home, you'll find the GC-1092D the easiest way ever to keep on time and up to date. Less batteries.

Kit GC-1092D, 5 lbs., mailable .. **Was 82.95 SALE 69.95***

GC-1092A & GC-1092D SPECIFICATIONS — Power requirement: 120 VAC, 60 Hz, 7 watts. **Accuracy with AC line:** Determined by accuracy of power line frequency. **Accuracy with battery:** Depending on care in initial calibration, battery discharge curve, and temperature. **Dimensions:** 8⅜" W x 4⅞" D x 2½" H (4" H with pedestal). **Display:** 6 digits, 7 segment neon planar.

Electronic Clocks and Watches — a complete guide to electronic timekeeping with sections on digital circuits, timebases and more. Includes instructions for two projects.
EDP-201 ..... **6.50***

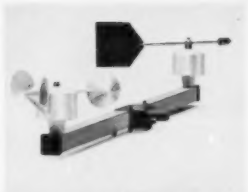
*$10 minimum order for book **only** purchase. No minimum when book order accompanies kit order. Include 35¢ for each book to cover postage and handling.

Hurry, sale prices end January 2, 1976!

New Low Prices on Digital Clocks

A)

Three styled-to-match kits show the time, temperature and windspeed in big, easy-to-read digits. From left to right, the GC-1005, ID-1390 and ID-1590.

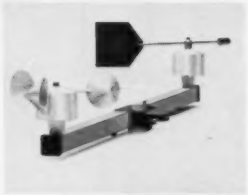


The remote transmitter assembly for the ID-1290 and ID-1590 clamps easily to any TV antenna mast.

New

B)

C)



The remote transmitter assembly for the ID-1290 and ID-1590 clamps easily to any TV antenna mast.

SAVE $10.00

D)

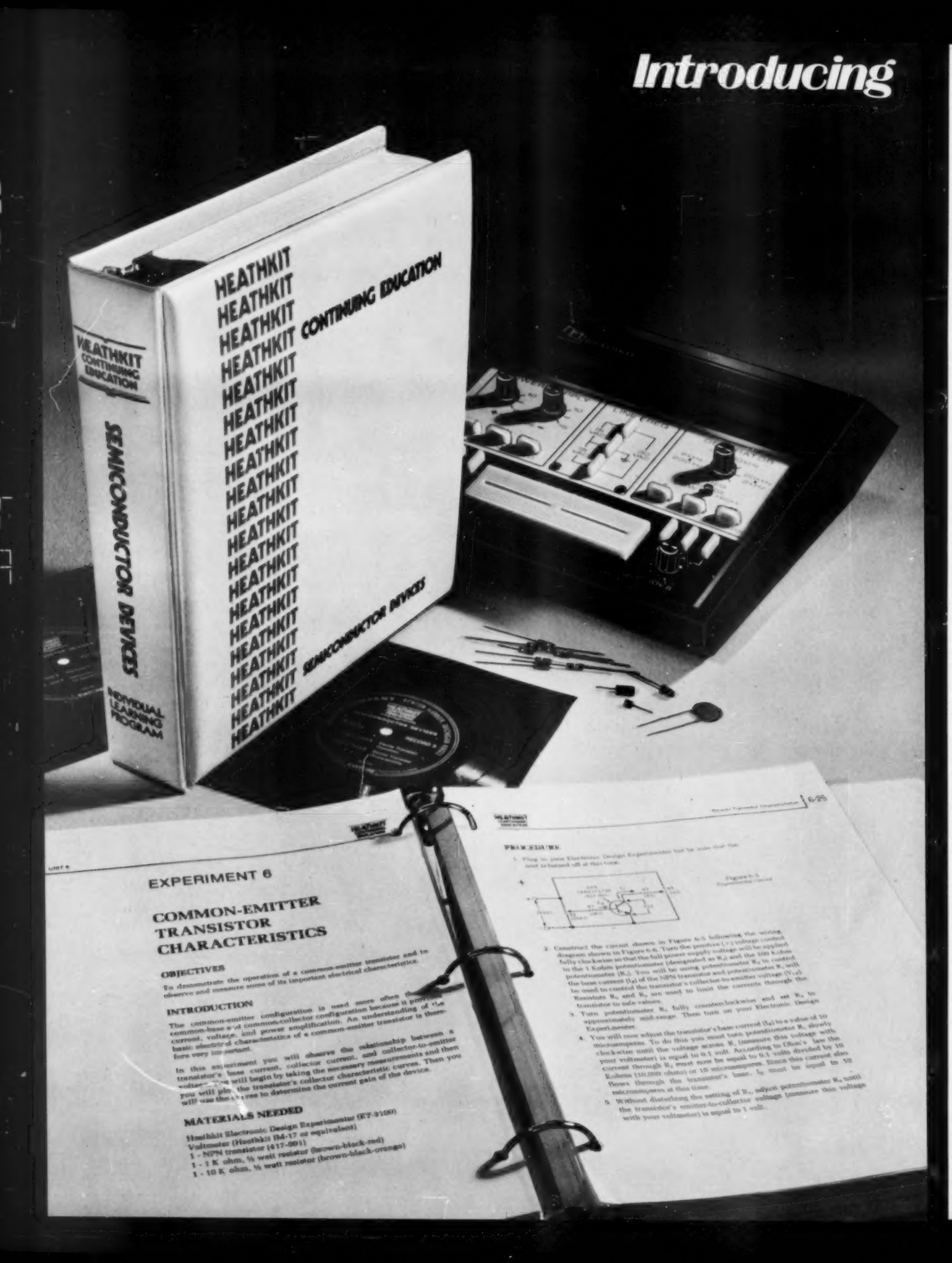
SAVE $13.00

SAVE $3.00

E)

F) The GC-1092A & D can be used with or without their pedestal bases.

Introducing



Heathkit Continuing Education series

NEW—Heathkit Individual Learning Programs. Self-instructional electronics courses designed to give you more knowledge in a shorter time, at less cost!

Heathkit Continuing Education

Education has always been a part of Heath's business philosophy—a subtle part of every kit. Now, with the establishment of the Heathkit Continuing Education series, we offer you the more formal learning opportunities you've asked for...with the quality and thoroughness you've come to expect of Heath. To keep you in tune with this changing, increasingly complex world...expand your horizons...improve your technical competence...and add to your enjoyment of electronics. Learning can be fun...easy...and inexpensive...with these new Heathkit Individual Learning Programs.

HEATHKIT CONTINUING EDUCATION

Your Personal Learning System

Multi-Media Programmed Instructions with Coordinated Experiments and Experimental Trainer.

You Set the Pace

A system that is "you" oriented. Designed for independent study at your own pace. No teachers, no schools, no library reading. The system of programmed instruction units not only teach you the subjects, but also how to learn thoroughly, efficiently, fast. Modern educational techniques lead you quickly to an understanding of fundamental electronic theories. Comprehensive learning guides take you through, step-by-step, integrating and reinforcing with coordinated kit experiments. Finally, self-evaluation quizzes help you check your progress.

Listen to Learn

Multi-media makes learning more interesting and faster paced. Heathkit programs incorporate not only a variety of printed materials and experiments, but also audio records to provide you with an introductory overview of the subject and periodic reviews of pertinent topics. A unique learning experience. Fast, effective, fun.

Experiments & Parts

Coordinated experiments reinforce each subject. Actual "hands on" experiences that help you learn, and give you practical applications of the subject. And all the parts for every experiment are provided with each course. You learn by doing!

Easy-To-Use Trainers

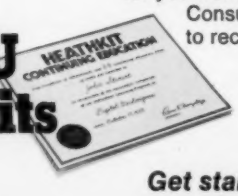
Experimenter Trainers. Low cost options to help you more conveniently perform the experiments as you study...and useful later for breadboarding your own design projects. Perfect for testing components and circuits. Solderless sockets for fast connections. Built-in power supplies, signal sources, and controls. All-in-one convenience and versatility.

The Fast, Simple, Inexpensive Way To Learn

As low as $39.95 a course

Just what you want. Individual instruction programs with the back-up hardware you need to make them thorough and fast (as little as 15 hours completes an individual program). Inexpensive, too (courses in the Electronic Fundamentals group cost as little as $39.95, the Digital Fundamentals course only $49.95). And those low prices get you all the text materials, records, and experiment parts. The only extra-cost options are the Experimenter/Trainers at $59.95 and $69.95. And you can order a combination of courses and trainers and save up to $25!

CEU Credits



You are in control. This is your personal program...you decide what courses you want to take, how far you want to go. No school, no admission requirement. No instructors, but Heath's Technical Consultants will answer your every question. No lesson tests to submit. But if you want to receive recognition for completing a program you can submit the optional final exam. A passing grade brings you a Certificate of Achievement and Continuing Education Unit (CEU) credits. CEU credits are a nationally recognized means of acknowledging your participation in formal adult education and are recognized by many employers and formal educational institutions.

Get started now! See full information on next pages.

Learn electronics this fast,

"Electronics Fundamentals"
—a comprehensive series that gives you a solid, practical foundation in electronics

DC Electronics Course
Course only 39.95
Trainer only 59.95
DC Course & Trainer 89.95

DC Course & Trainer, only 89.95

AC Electronics Course
(available mid-January)

Course only, 39.95
Course & Trainer 89.95

SAVE 24.85
Buy all 3 Electronics Fundamentals Courses and the Experimenter/Trainer.
Only 154.95

Coming in early 1976
Part 4 of the Electronics Fundamentals Course, "Electronic Circuits and Applications."

Semiconductor Devices Course

Course only, 39.95
Course & Trainer 89.95

"Digital Techniques"
—you learn digital logic, circuits, application, and equipment with emphasis on integrated circuits.

Digital Techniques Course, 49.95
Digital Experimenter/Trainer, 69.95
Digital Course & Trainer, only 109.95

easy, low-cost way

"Electronics Fundamentals"... in 4 easy steps.

The four Individual Learning Programs in this series provide a complete overview of the subjects vital to an understanding of electronics. These subjects include electrical principles, electronic component operation and application, and the theory of operation of all basic electronic circuits.

Foundations for Specializing

The four programs are general in nature and do not emphasize any one particular electronic specialty. Instead, the programs provide a solid educational foundation in basic electronics for anyone wishing to later pursue specialties such as communications, digital electronics and computers, industrial and consumer electronic equipment repair.

Learn How Your Kits Work.

The programs also are ideal for hobbyists and experimenters who want to know more about electronics...who want to really understand how their kits work...to expand their hobby to its fullest satisfaction.

Take only those programs you need.

Because of their modularity, the individual programs in Electronic Fundamentals are very flexible. You need purchase only those programs covering the subjects in which you have an interest or need. Although each program is a prerequisite for the next, other experience or training is also applicable. You decide whether you meet the prerequisites for each. The first program, DC Electronics, assumes no prior knowledge of electronic principles. Anyone who is a high school graduate should be able to complete the program.

Up-to-date.

These programs are the latest...up-to-date in technology to keep you up-to-date in knowledge. Emphasis is on semiconductor technology, both discrete components and integrated circuits. See the course outlines in the next column...order those now that you need to get in step with the expanding world of electronics.

"Electronics Fundamentals" Course Outlines.

Part 1—"DC Electronics" Text/Records/Parts
Electronic principles, laws, theories; component operation, characteristics, use; measurement techniques, basic circuits, practical applications. *Prerequisites:* high school or equivalent. *Average min. completion time:* 20 hours. *Credit:* 2.0 CEU and Certificate for passing optional final exam. *8 Unit-Subjects:* 1. Electron Theory; 2. Voltage; 3. Resistance; 4. Ohm's Law; 5. Magnetism; 6. Electrical Measurements; 7. Network Theorems; 8. Inductance & Capacitance. *Optional equipment needed:* Heath IM-17 VOM or equivalent; soldering iron, small tools; record player; Heathkit Experimenter/Trainer.

Model EE-3101, DC Electronics, 5 lbs. **39.95**
Kit ET-3100, Experimenter, 6 lbs., mailable, **59.95**
Models 3101 & 3100 ordered together, only **89.95**

Part 2—"AC Electronics" Text/Records/Parts
Alternating current principles; effect on resistive, inductive, capacitive components; circuits, applications. *Prerequisites:* completion of Heathkit DC Electronics program or equivalent experience. *Average min. completion time:* 15 hours. *Credit:* 1.5 CEU and Certificate for passing optional final exam. *6 Unit-Subjects:* 1. AC Fundamentals; 2. AC Measurements; 3. AC in Capacitive Circuits; 4. AC in Inductive Circuits; 5. Transformers; 6. Tuned Circuits. *Optional equipment needed:* Heath IM-17 VOM or other; soldering iron, small tools; record player; Heathkit Experimenter/Trainer.

Model EE-3102, AC Electronics, 5 lbs. **39.95**
Kit ET-3100, Experimenter, 6 lbs., mailable, **59.95**
Models 3102 & 3100 ordered together, only **89.95**

Part 3—"Semiconductor Devices" Text/Records/Parts
Operation, characteristics, basic application of commonly used semiconductors. *Prerequisites:* completion of Heathkit DC and AC Electronics programs or equivalent experience. *Average min. completion time:* 30 hours. *Credit:* 3.0 CEU and Certificate for passing optional final exam. *10 Unit-Subjects:* 1. Semiconductor Fundamentals; 2. Semiconductor Diodes; 3. Zener Diode; 4. Special Diodes; 5. Bipolar Transistor Operation; 6. Bipolar Transistor Characteristics; 7. Field Effect Transistors; 8. Thyristors; 9. Integrated Circuits; 10. Optoelectronic Devices. *Optional equipment needed:* Heath IM-17 VOM or other; soldering iron, small tools; record player; Heathkit Experimenter/Trainer.

Model EE-3103, Semiconductor Devices, 4 lbs., mailable **39.95**
Kit ET-3100, Experimenter, 6 lbs., mailable, **59.95**
Models 3103 & 3100 ordered together, only **89.95**
Order all 3 Courses & Experimenter for only **154.95**

"Digital Techniques"...key to tomorrow.

This Individual Learning Program is designed for engineers, technicians, scientists, and hobbyists who need a good understanding of modern digital techniques to stay up-to-date.

Making "Impossibles" Realities.

Today, digital techniques are used virtually everywhere in electronics. Integrated circuits have made digital techniques a realistic alternative to analog methods. And digital techniques permit sophisticated control and measurement formerly impossible or impractical.

Expand Your Horizons

Sooner or later, everyone in electronics and other sciences will encounter the need to know digital techniques. As technology becomes more sophisticated and applications broaden in scope so you, too, must expand your basic knowledge to keep pace.

Prepare Today.

The Heathkit Digital Techniques program will provide you with a solid background in digital fundamentals. Get ready today for tomorrow.

"Digital Techniques" Course Outline.

Fundamentals and applications. Course includes text, records, and parts. *Prerequisites:* good technician or engineer electronics knowledge or experience; algebra. *Average min. completion time:* 40 hours. *Credit:* 4.0 CEU and Certificate for passing optional final exam. *10 Unit-Subjects:* 1. Introduction (techniques and use, binary numbers, digital codes). 2. Semiconductor Devices for Digital Circuits. 3. Digital Logic Circuits (AND gates, OR gates, NAND/NOR logic etc.). 4. Digital Integrated Circuits (TTL, ECL, CMOS, nMOS, pMOS; how to choose). 5. Boolean Algebra. 6. Flip-Flops and Registers (latches, D & JK flip-flops, storage registers, applications). 7. Sequential Logic Circuits (binary, BCD modulo N, up/down, counters, dividers, shift registers, etc.). 8. Combination Logic Circuits (encoders, decoders, exclusive OR, comparators, multiplexer, ROMs, PLAs, etc.). 9. Digital Design (how to design combinational and sequential logic circuits, procedures, etc.). 10. Digital Applications (test equipment, digital counters, digital computers, microprocessors). *Optional equipment needed:* Heath IM-17 VOM or other; soldering iron, small tools; record player; Heathkit Digital Experimenter/Trainer.

Model EE-3201, Digital Techniques, 5 lbs., mailable **49.95**
Kit ET-3200, Digital Experimenter, 6 lbs., mailable **69.95**
Model 3201 & 3200 when ordered together, only **109.95**

Order your Experimenter with your courses and save! Use them as you learn— use them later in projects.

Heathkit Electronic Design Experimenter/Trainer.
Designed for Heathkit Electronic Fundamental courses, the ET-3100 helps you get the most in learning experiences by giving you all the facilities for performing every experiment in a fast, easy way. And when you've finished your courses, you'll find the Experimenter/Trainer perfect for "breadboarding" design projects at your job or at home. Great for school labs, too! Check these convenient features:

- Solderless breadboarding socket for fast, easy circuit connections without damage to components. Just plug in components with lead diameters up to .032". Socket has 96 terminals with 5 common connections each, arranged as 48 pairs. Uses standard #24 or 22 solid hook-up wire for connections.
- Dual, variable power supplies for positive and negative voltages (both variable over 1.2 to 16 volts, current rating 120 mA, both regulated and short-circuit protected).
- Built-in 2-range sine and square wave signal sources, variable 200 Hz to 20 kHz. Sine wave output is 1 v. rms at 600 ohms impedance, distortion less than 1%. Square wave output is 15 v. peak-to-peak, rise/fall times less than 1 microsecond, duty cycle 30%.
- Center-tapped power transformer secondary provides 30 v. rms, 60 Hz for power line experiments.
- Built-in 1K and 100K ohm linear potentiometers.

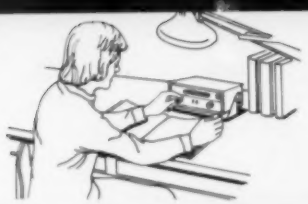
Make it easy, while you learn and after, with the Heathkit Electronic Design Experimenter.
Kit ET-3100, 6 lbs., mailable **59.95**

Heathkit Digital Design Experimenter/Trainer.
Use it while you study your Heathkit Digital Techniques course to perform all the experiments. Use later on the job or at home to develop projects, build and test prototypes, verify circuit operation, check digital ICs. Perfect experimental chassis for school labs as well. It's self-contained, nothing else is needed...just plug it in. It features:

- 3 regulated power supplies; +12 v., 100 mA current limited; −12 v., 100 mA current limited; + 5 v., 500 mA, overload protected.
- 4 binary data switches (+ 5 v. and 0 v.), maximum current 10 mA each switch.
- 2 "no bounce" (flip-flop latched) spring return (momentary contact) logic switches to pulse logic circuits.
- 3-frequency pulse clock generator (1 Hz, 1000 Hz, 100 kHz ±20%), rectangular waveform, 5 v. peak-to-peak, for normal and complementary logic signals.
- 4 red LEDs (light emitting diodes) for visual indication of the logic states.
- Compatible with DTL, TTL, CMOS, nMOS and pMOS integrated circuits; RTL and ECL circuits can be accommodated with minor circuit additions.
- Solderless breadboarding socket for fast plug-in connections; accepts component lead diameters up to .032"; contains 128 terminals with 5 common points each, arranged in 64 pairs; will accommodate up to eight 14 or 16 pin dual in-line ICs. DIPs in 24, 28, and 40 pin packs can also be handled. Digital design comes easy with the "3200".

Kit ET-3200, 6 lbs., mailable **69.95**

Listen in on the world...



6 EVENING KIT

Heathkit VHF/FM scanning monitor lets you listen in on all the local action...99.95

Covers any 9 MHz between 146-174 MHz
Digital readout
Manual or automatic scanning
Priority channel for calls you can't afford to miss
Adjustable squelch control
Runs on either 120 VAC or 12 VDC for fixed or mobile operation

Fire, police, emergency vehicle, marine, weather, amateur two meter FM, commercial radio, mobile and marine telephone calls . . . that's just some of the fascinating activity on VHF FM. And it's all yours with the Heathkit GR-110 scanning monitor.

Tunes any 9 MHz segment of the 146-174 MHz band, and you can choose up to eight separate crystals to cover the frequencies in use in your area (check state and local laws regarding use of monitors in vehicles in your locality). In the manual scanning mode you can manually select any channel from 0 through 7, with bright digital readout. The monitor stays locked on that frequency until you manually select another, or go to the automatic scanning mode. In automatic, the monitor rapidly scans all eight channels and locks on to the first one that starts a transmission. It will remain on that channel as long as a signal is present; when the signal stops, the monitor waits four seconds, then continues scanning.

A priority channel "0" takes precedence over all other channels; the monitor will return to "0" whenever a station comes on that frequency, even though it might have already been locked on another channel. Front panel pushbuttons let you lock-out any channels, and the monitor automatically bypasses them as it scans.

Easy 4-evening assembly with the famous Heathkit manual, and during assembly you can wire the monitor to display the channel number only when it is locked on a frequency or continuously as it scans. Line cords and plugs for both 120 VAC and 12 VDC are provided.

Features include built-in speaker plus external speaker jack . . . antenna jack . . . gimbal mount . . . complete front panel controls for volume, squelch, channel selection and scanning mode. Manual gives complete instructions on alignment and crystal ordering.

Kit GR-110, 9 lbs., mailable **99.95**
GRA-110-1, Crystal Certificate, postpaid . . . . . each **4.95**

GR-110 SPECIFICATIONS — Frequency Range: 146 to 174 MHz. **Scanning Range:** Any 9 MHz segment of frequency range. **Sensitivity:** Less than 1 μV for 20 dB of quieting. **Usable Sensitivity:** Less than 0.5 μV. **Adjacent Channel Rejection:** —40 dB (±30 kHz spacing). **Intermediate Frequency (IF):** 10.7 MHz, crystal filter. **IF Rejection:** Greater than —80 dB. **Image Rejection:** Greater than —40 dB. **Modulation Acceptance:** 7.5 kHz maximum. **Antenna Input Impedance:** 50 ohms. **Scan Rate:** Approximately 17 channels per second. **Audio Output:** 2 watts into a 4-ohm load, with less than 10% distortion. **Solid-State Devices:** 29 transistors, 8 integrated circuits, 17 diodes. **Readout Device:** 3015A, 7-segment indicator tube. **Power Requirements:** AC: 120 volts, 50/60 Hz; 13 watts. DC: 13.8 volts. Squelched .275 amperes. Unsquelched with full audio, 0.8 amperes. **Dimensions:** 3" H x 8¼" W x 9⅜" D.

Portable VHF/FM monitors...59.95

Kit GR-88, VHF/FM Fire, Weather, Police Monitor, 5 lbs., mailable **59.95**
Kit GR-98, Aircraft Monitor, 5 lbs., mailable **59.95**
Kit GRA-88-1, AC power supply for both above, 2 lbs., mailable. . **9.95**

GR-88 SPECIFICATIONS — Tuning range: 152-174 MHz. **Antenna input:** 50-75 ohms. **Sensitivity:** 2.0 μV or less for 20 dB quieting. **IF frequency:** 10.7 MHz. **IF selectivity:** ±40 kHz @ 6 dB down. **Image rejection:** 40 dB or greater. **IF rejection:** 80 dB or greater. **Audio output:** 250 mW at less than 10% distortion. **Speaker:** 3" round, 24-ohms, permanent magnet. **Transistor complement-tuner:** (2) 2SC784 and (1) SE-5006. **Transistor complement-IF audio:** (5) 2N2369, (4) 2N3393, (1) X29A829, (1) 2N2430, (1) 2N2431, (1) 40481. **Diode complement:** (2) 1N191 and (2) 1N4646. **Batteries:** Six 1.5 V "C" cells, not supplied. **Dimensions:** 7½" H x 8¾" W x 3½" D.

GR-98 SPECIFICATIONS — Tuning range: 108-136 MHz. **Antenna input:** 50 to 75 ohms. **Sensitivity:** 1.5 μV or less for 10 dB signal plus noise to noise @ 1000 Hz 30% modulation. **IF frequency:** 10.7 MHz. **IF selectivity:** 40 kHz @ 6 dB down; 100 kHz @ 30 dB down. **Image rejection:** 40 dB or greater. **IF rejection:** 80 dB or greater. **Audio output:** 250 mW at less than 10% distortion. **Speaker:** 3" round, 24 ohm, permanent magnet. **Transistor complement-tuner:** (2) 2SC784 and (1) SE-5006. **Transistor complement-IF & audio:** (4) 2N2369, (3) 2N3393, (2) Z29A829, (1) 2N2430, (1) 2N2431 and (1) 40481. **Diode complement:** (2) 1N191, (1) 1N4646 and (1) S-160. **Batteries:** Six 1.5 V size "C" cells (not included). **Dimensions:** 7½" H x 8¾" W x 3½" D.

Shortwave Listener's Handbook — covers everything from basic equipment to modifications for better listening, characteristics of receivers and antennas, how to get schedules and reception reports, lists major shortwave stations by country and frequency.
EDP-196 . . . . . **4.90**

ABCs of Shortwave Listening — tells what programs are available, how to get the most out of shortwave listening; practical advice on receivers & antennas in nontechnical terms.
EDP-154, ... **2.95**

99 Ways to Improve your Shortwave Listening — covers antennas & their installation, receivers, accessories, listening techniques, special bands & signals, troubleshooting tips.
EDP-155, ... **4.50**

How to Hear Police, Fire and Aircraft Radio — a guide to VHF police, fire & aircraft reception; covers home & mobile installations.
EDP-156, ... **3.50**

Dial 911 — exciting story of emergency communications systems and surveillance techniques, including specific information on New York City, Los Angeles & Philadelphia.
EDP-198 . . . . . **3.95**

Heathkit assembly manuals are famous for their simplicity and completeness

with Heathkit SWL gear

A) Get six band coverage...AM, SSB & CW reception...and portability, just...159.95

A fine medium cost receiver the Heathkit GR-78 is a favorite of SWLs and hams who need a standby receiver, and everyone who desires portability. Loaded with features: 190 kHz to 30 MHz coverage in 6 bands . . . AM, CW and SSB reception . . . Automatic Volume Control . . . switched Automatic Noise Limiter . . . front panel "S" meter . . . 500 kHz crystal calibrator . . . receiver/standby switch . . . muting connection . . . external antenna connection . . . headphone jack . . . built-in whip antenna. Kit includes nickel-cadmium battery with built-in charger.

Kit GR-78, 14 lbs., mailable **159.95**

GR-78 SPECIFICATIONS — Frequency coverage: Band A, 190 kHz-410 kHz; Band B, 550 kHz-1300 kHz; Band C, 1.3 MHz-3.0 MHz; Band D, 3.0 MHz-7.5 MHz; Band E, 7.5 MHz-18.0 MHz; Band F, 18.0 MHz-30 MHz. **Meter:** Indicates relative signal strength. **Intermediate frequency:** Band A thru E: 455 kHz; Band F (Double conversion): 1st IF, 4.034 MHz; 2nd IF, 455 kHz. **Sensitivity*:** 0.2 μV — 10 μV depending on band and portion thereof. **Selectivity:** 7.5 kHz ±1 @ 6 dB down. **Audio output:** 300 milliwatts @ 10% distortion. **Battery:** 9.6 VDC 500 mAh Nickel-Cadmium rechargeable. **Battery charge rate:** The battery is always being charged at 20 to 25 mA when the built-in trickle charging circuit is connected to an external power source with the Receiver turned off. A full battery charge will be maintained if the Receiver is connected to an external power source and used an average of 5 hours daily at normal listening level. **Overall size:** 6¼" H x 11½" W x 9" D.

*Signal level for 10 dB signal + noise/noise ratio.

B) Our finest SWL receiver... the famous Heathkit SB-313...389.95

Provides AM and CW reception on 9 bands from 3.5 to 21.8 MHz. 5 kHz AM crystal filter supplied with the kit; optional CW crystal filter available for optimum selectivity. Advanced-design solid-state circuitry delivers excellent stability and sensitivity. Factory assembled & aligned Linear Master Oscillator for superior linearity, dial tracking and stability. Features include IC crystal calibrator for 25 & 100 kHz markers...three-position AGC...front panel "S" meter...RF attenuator...smooth, backlash-free tuning. Requires 8-ohm speaker or headphones plus VTVM and antenna for alignment.

Kit SB-313, 22 lbs., mailable **389.95**

Kit SB-600, 8-ohm 6" x 9" speaker & cab., 7 lbs., mailable **22.95**

SB-313 SPECIFICATIONS — Frequency Range (MHz): 3.5 to 4.0, 5.7 to 6.2, 7.0 to 7.5, 9.5 to 10.0, 11.5 to 12.0, 14.0 to 14.5, 15.0 to 15.5, 17.5 to 18.8, 21.3 to 21.8. **Intermediate Frequency (IF):** 3.395 MHz. **Frequency Stability:** Less than 100 Hz per hour after 10 minutes' warmup under normal ambient conditions. Less than 100 Hz drift for ±10% line voltage variation. **Sensitivity:** Less than 0.5 microvolt for 10 dB signal plus-noise to noise ratio for SSB operation. **Selectivity:** AM: 5.0 kHz at 6 dB down, 15 kHz maximum at 60 dB down (crystal filter supplied). CW: 400 Hz at 6 dB down, 2.0 kHz maximum at 60 dB down (crystal filter available as an accessory). **Image Rejection:** 60 dB or better. **IF Rejection:** 3.395: Greater than 55 dB. 8.595: Greater than 40 dB. **Spurious Response:** All below 1 microvolt equivalent signal input except at 10.0 MHz and 15.375 MHz. **Dial Accuracy:** Electrical: Within 400 Hz after calibration at nearest 100 kHz point. Visual: Within 200 Hz. **Calibration:** Every 100 kHz or 25 kHz. **Dial Backlash:** No more than 50 Hz. **Antenna Input Impedance:** 50Ω nominal unbalanced. **Audio Output Impedance:** Matching Speaker: 8Ω. Matching Headphones: Low impedance. **Audio Output Power:** 4 watts at less than 10% distortion. **Muting:** Open external ground at Mute socket. **Power Requirements:** 105 to 130 or 210 to 260 volts, AC, 40 watts max. **Overall Dimensions:** 7¹⁵⁄₁₆" H x 12¼" W x 14" D.

C) Low cost 4-band receiver...69.95

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12	1.32	1.50	1.80	2.12	2.57	3.07	3.61
13	1.38	1.58	1.90	2.24	2.73	3.27	3.85
14	1.44	1.65	2.00	2.36	2.88	3.46	4.09
15	1.50	1.73	2.10	2.48	3.04	3.66	4.33
16	1.56	1.80	2.20	2.60	3.19	3.85	4.57
17	1.62	1.88	2.30	2.73	3.35	4.05	4.81
18	1.68	1.95	2.40	2.85	3.50	4.24	5.05
19	1.74	2.03	2.50	2.98	3.66	4.44	5.29
20	1.80	2.10	2.60	3.10	3.81	4.63	5.53
21	1.86	2.18	2.70	3.23	3.97	4.83	5.77
22	1.92	2.25	2.80	3.35	4.12	5.02	6.01
23	1.98	2.33	2.90	3.48	4.28	5.22	6.25
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130-152	4
153	5
154-160	4
161	3
162-163	4
164-165	3
166-199	4
200-232	4
233-237	5
238-259	4
260-261	3
262-278	4
279	5
280-283	4
284-285	5
286-293	4
294-295	5
296-297	4
298-299	5
300-303	4
304	5
305-307	4
308-329	5
330-334	4
335-338	5
339	6
350-352	4
354	5
355-359	4
360-361	5
362	4
363-369	5
370-386	4
387	5
388	4
389-397	5
400-406	3
407-409	4
410-412	3
413-422	4
423	3
424-426	4
427-432	3
433-436	2
437-457	3
458	2
460-462	3
463-464	2
465-466	1
467-469	2
470-472	3
473	2
474-475	3
476-477	4
478	3
479-489	2
490-491	1
492	2
493-495	1
496-499	3
500-516	4
520-524	3
525	4
526-528	3
530-534	2
535-539	3
540	4
541-546	3
547-548	4
549	3
550-566	4
567	5
570-572	4
573-588	5
590-597	6
598-599	7
600-609	2
610-619	3
620-623	4
624-628	3
629-668	4
669-679	5
680-687	4
688-693	5
700-722	5
723-727	4
728-768	5
769	6
770-778	5
779-789	6
790-792	5
793-799	6
800-803	5
804-805	6
806-807	5
808-818	6
820-822	5
823-826	6
827	8
828-832	6
833	7
834	8
835-838	7
840-847	6
850-864	7
865-884	6
890-898	7
900-921	8
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Build This $5 Timer

by
P. C. Walton VE3FEZ
421 Lodor Street
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Do you have a TV in your bedroom? Have you ever fallen asleep and left it on? Or even worse just find yourself falling asleep and remember that you have to get up and turn it off? This versatile timer will turn the TV off from periods of three minutes after you have gone to sleep to periods up to about one hour. You can build this timer in one evening for a total cost of about $5 even if you have to buy all new components. The circuit I used, shown in Fig. 1, takes advantage of a new integrated circuit from the Signetics Company called the NE555. The NE555 is a very stable monolithic timing circuit in the form of an 8-pin dual in line package. It is currently selling for $1 from most suppliers.

The NE555 is capable of time delays from a few microseconds up to several hours. These delay periods are dependent on an external RC network consisting of one resistor and capacitor.

Very basically the IC is made up of a voltage comparator circuit, one leg of which is connected to a reference voltage which in our case is the power supply output voltage. The other leg of the voltage comparator is connected to the external RC network. When the capacitor has charged to a voltage equal to the reference voltage the comparator will toggle a flip flop connected to its output. The ON level of this flip flop is used to turn on a driver circuit which picks up our time delay relay. This is a very basic description of a fairly complex IC. If you require a better explanation of the internal workings you can obtain one by writing to the Signetics people and requesting a data sheet.

The relay I used was an IRC MR312 C with a coil resistance of 212Ω. Almost any 12V relay will do the job as long as it does not draw more than 200mA from the output of the NE555 which is rated at 200mA. The RC network is a 100μF capacitor in series with a 5MHz linear pot and a 1MHz resistor. These values with the power supply that I used gave time delays of 3 minutes at the low resistance end of the pot and 58 minutes at the high resistance end.

You may have to experiment a little bit to get the exact time delay range that you require. This is due to possible differences in power supply voltage and components. You could even switch in different values of R and C with a rotary switch to give you several different time delay ranges. The power supply is just an old 6V filament transformer that was in the junk box and a full wave rectifier and filter capacitor. Parts layout is not at all critical and the whole unit can be kept very small. I built mine on a scrap piece of perfboard about 5.08W x 7.62cmL (2"W x 3"L). The completed circuit board is mounted in a standard minibox using a three wire power cord for safety. On the front of the box is just a standard 110V three wire receptacle, the pot for setting the time delay period and the pushbutton to start the timer. The time delay pot was calibrated using an ordinary clock and a lot of patience. ■

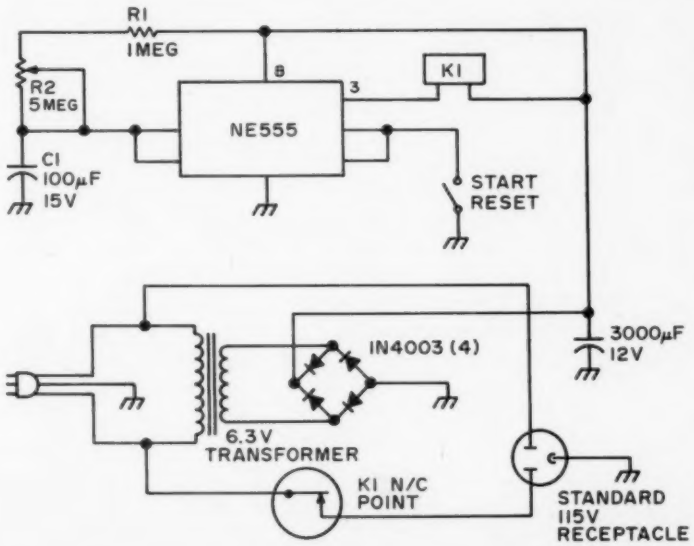


Fig. 1.

A $50 Self-Powered Counter

by
Jim Huffman WA7SCB
PO Box 357
Provo UT 84601

To you this may look like another construction article. "A pretty neat little counter," you'll say. "Think I'll build one." Little will you know how long it took me, and how much sweat is in one factor – cost. I love to get the cost on a project as low as possible through judicious shopping. It is my dream to offer all kinds of low-priced amateur gear ... again! Some guys, like VHF Engineering, seem to be out to help the amateur by keeping the "amateur" in amateur radio. Others, however, look to me like they are out to soak the ham, right along with the CBer, consumer and anyone else who wants one of what they've got. I have written a bunch of articles for *73*, and all of them are on good inexpensive items that I think can put the "fun" back in amateurism. This article is one of my greatest achievements – the pinnacle of savings! I take great pride in accomplishing what I have done here. A 6-digit (that reads out to a full 8-digit capacity) counter, portable, hand-held, sensitive, rugged, LED readouts, requires no test equipment to build, and more, all for just a little over $50!

Costs are sliced down to an absolute minimum by cutting all the frills. For instance, many counters advertise no-flicker, or non-blinking readout. I am proud to announce that this one blinks, but you can only see it on the lowest reading scale, when you are reading signals to 1 Hz. The rest of the time the digits blink for 1 ms, and when was the last time you could see a 1 ms blink? Most hams will use the MHz and kHz scales most of the time anyway so the "blink" will be for 10 us and 1 ms respectively. And, when you are showing the XYL or neighbor your latest creation, show 'em on the Hz range so they will be impressed by the blinking, counting readouts!

While cutting out the non-blinking feature does save some money, the greatest saver is cutting out 3 of the 6 digits! I know, you are wondering how it is that we get a 6-digit counter with 3 of the digits missing. At current prices, dropping 3 unnecessary digits saves nearly $25. Even at TWS a 3 DCU costs $18. So if you can liberate an extra $18 for this project, you can have all 6 digits! But it is all the more fun to drop 3 digits, build the unit in half the width, and shift the readouts around to get a look at 8 digits of the incoming signal. Even in a 6-digit counter you have to shift the range switch around to get readout of say a 14.85 MHz signal to the nearest 1 Hz! With the Handi-Counter you have just one more shift to get the same capability with only 3 digits!

The basic "brains" for the counter come

from a kit available from TWS Labs. So order a digital dial kit from TWS Labs, PO Box 357, Provo UT 84601 for $45.95. When you order the digital dial, you get the same stuff you would get if you order the individual kit (a 3 DCU and a timebase), but you get a free ac power supply in addition. In fact, you can power your unit from this supply if you don't want to add nicads like in this version of the Handi-Counter. Or you can keep the power supply and have a good source of fairly well regulated 5 V dc for your workbench. The fact that the basic counter comes in kit form makes this project all the easier. All you need to do is make some very simple modifications to the kit, add the digit switching circuit and a couple of extra circuits on perfboard, and walla! Instant 3 x 6 digit counter!

Operation

Let's look at how you use the unit before you build it. Actually, the principle of operation is so simple that it is a wonder someone didn't think of it before (maybe someone did . . . better check my back issues of *QST*). You can see from the photo that there are several front panel controls. First is the on/off switch, simple enough function there. Second is the MHz/kHz selector (both these switches come with the kit); this one selects timebases, and does some decimal point selection. We could have labeled it Hz/kHz like its 6-digit brothers; it would only have required putting the decimal points in some other places that were not convenient (and cheap) with this kit.

The third switch, the one in the middle of the panel, we can call the "display selector" switch. This one comes from your corner Radio Shack and is p/n 275-405, a 4 PDT switch that currently is priced at 69¢. Other than the box and batteries, this is the only expenditure that is not available in a kit. You could have a complete counter that would only read to 100 Hz so far. You either add my famous circuits shown in the article, or buy another kit from TWS Labs for the 1 Hz capability.

Back to the 4 PDT switch. It is used to select which 3 digits of the 6 available digits are viewed at any one time. When you throw the switch to the left, you see the left most significant digits and to the right, you see the 3 right most significant. The decimal point jumps around every time to keep you thinking straight. Fig. 1 shows how it works. For an example, we used a forty meter signal that is actually 7,224,362 Hz. This is how the counter sees it: Note the placement of the decimal point; also note that in kHz left and MHz right, the readout is the same, but the decimal point is shifted. That is because, if you look at the original signal you can see

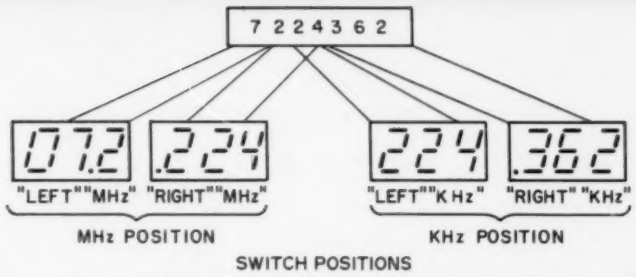


Fig. 1. Here is how the digital display in the Handi-Counter shows the eight complete digits in this forty meter signal. You simply move the digital display around and "look" at different portions of the signal at selected times.

that there are: 7.2 MHz, .224 MHz or 224 kHz (see, the readout means the same thing), and finally .362 kHz. That last 0.362 kHz is the same as 362 Hz, but would demand another timebase switch position, so we merely switch a decimal point and call it a fraction of a kHz.

Suppose you hook the sensitive input circuit of the counter to an oscillator you built the other day. You want a look at the output frequency of the oscillator. Maybe you see 21.8 on the MHz left setup; that means the oscillator is running at 21.8 MHz. If you were only interested in roughly knowing the MHz range of the oscillator, you would stop right there. If you wanted the kHz range you would leave the display left, and throw the timebase selector to kHz. That would give you a frequency check to the nearest kHz. Suppose you wanted further accuracy, or to know how much it

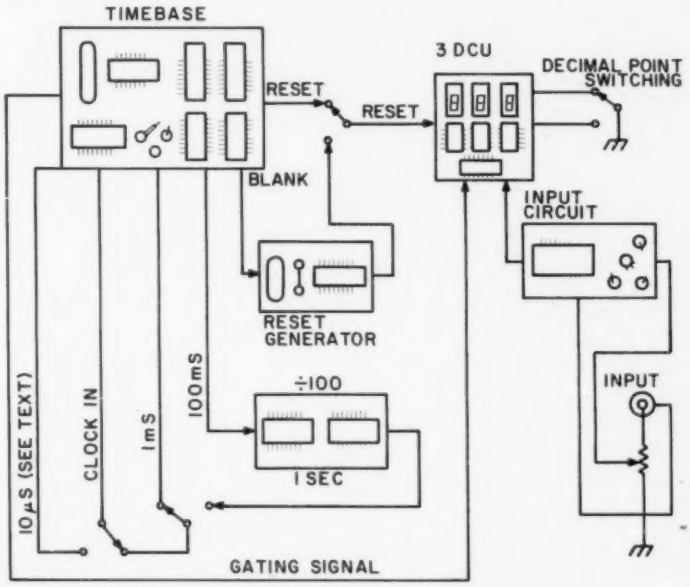
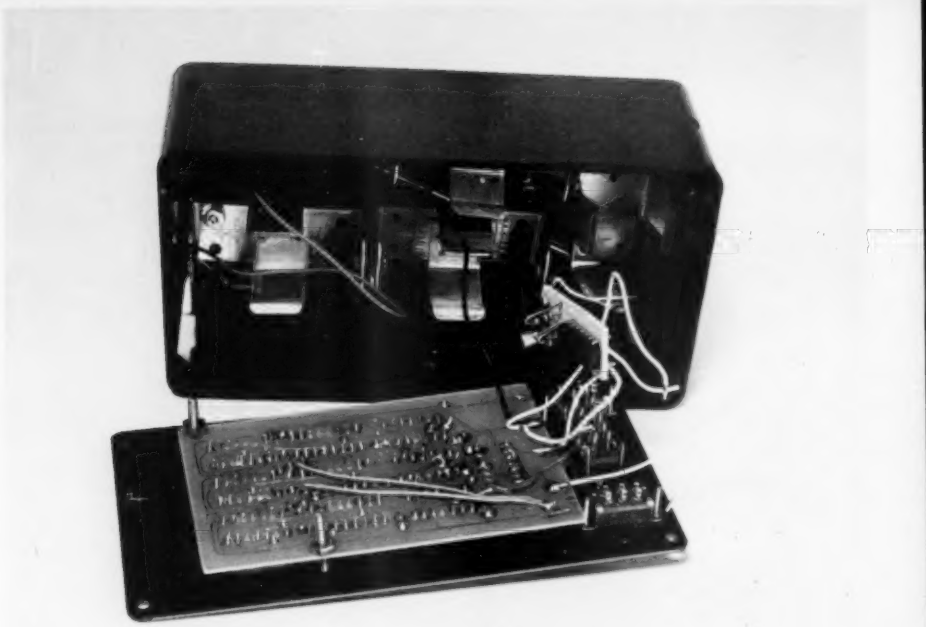


Fig. 2. This is the block diagram of the unit showing some of the switching that is accomplished with only two switches in the unit, a DPDT that comes with the timebase kit and an "added" 4 PDT.

Building the counter is really not hard – collect all the parts, do the layout of the front panel, and finally, mount the pieces in the box . . .



The first step in putting the thing in the box is mounting the front panel. Note the input circuit mounted on the switch. Later, the wires were extended so the input circuit could be mounted in the cavity formed by the irregular battery mounting.

drifts; then flip to the right digit display (still in kHz) and read out in Hz. You can see the flexibility of the whole thing! It's unreal! You have 3 digits in a lot smaller package, for a lot less cost and you are reading a 21 MHz signal out to eight places! Oh, the miracle of electronics . . .

Fig. 2 is the block diagram of the counter and this will help you understand what is going on in there. The easiest process takes place in the kHz position. Here, the timebase selector and display selector switches choose to provide a one second (right) or a 1 ms (left) signal. This is high-accuracy stuff with the timebase being divided by a million to get the one second clock; any errors or drift in the timebase oscillator (already crystal-controlled) are divided by the million too. At the very beginning of the count time (1 sec or 1 ms), the timebase gives a reset pulse that starts the counter stages at 000. Then the counter merely counts the input pulses that occur during the selected time period. On the kHz left position, for example, the counter is cleared and enabled for one second. When counting a 60 Hz line input, the counter would start to flash (the part that will impress the average observer) until the end of the counting cycle when it will sit there displaying .060 kHz, or 60 Hz.

When the display selector switch is pushed left, we apply a 1 ms gating signal to the counters and count the events that occur in 1 ms, or in other words, we count kHz. A 30 kHz signal will show up as 030. Note that there is no decimal point; there is no need, as the timebase selector is in the kHz position so it reads out as a whole number, not a decimal fraction. From the block diagram, when one switches to the MHz range, the clock now comes from 1 ms and 10 us. The 10 us clock is fed to the counter circuits in the "MHz left" position and merely allows the counter stages to count for 10 us. On this scale, the chance for error from the 1 MHz crystal is greater and the fact that the timebase is crystal-controlled becomes the greatest asset. At the 10 us

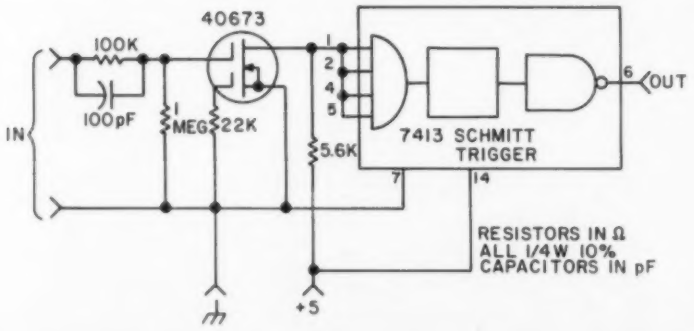


Fig. 3. Schematic diagram of the input circuit used with the Handi-Counter.

point the clock signal is only divided by ten. With 10 us gating the counter can count up to 99.9 MHz; in real life the limit is imposed by the fact that the counter circuits will only operate to 30-40 MHz without a prescaler. Since most prescalers divide the display by ten, you will display MHz on all three digits, so the decimal point can be left out.

It is probably a good idea to explain why there is a different reset circuit than the one with the kit. The reset circuit with the kit is designed to give high accuracy with fast input signals and operate at a 10 ms and 1 ms gating output. While the kit's reset is more accurate than the "extra one" built for the Handi-Counter, it causes some problems while running at slow speeds. The reset actually resets a couple of clock pulses *before* the gating signal enables the counter. That works great at 1 ms and 10 ms and means that you are not depending on the characteristics of the input impedance of a gate and some resistors and capacitors for your reset pulse; the pulse is clock controlled. The trouble comes when the clock is one second. The strobe circuit causes the counter to sample the input signal every second and a half or so and you can extend it to a few seconds by increasing the size of the timing capacitor in the unijunction oscillator circuit. Well, at one second clock speed, the counter resets to 000, waits a couple of clock pulses (seconds), then enables the counter stage and the stages count the input signal. After the one second counting period, it is time for another sample and the display resets again. The result is you don't have the display lit long enough with the number to even read it. You may choose to merely extend the sample time by putting more capacitance in parallel with the timing capacitor (33 uF) in the unijunction circuit that comes with the kit, or you may use the reset circuit shown here.

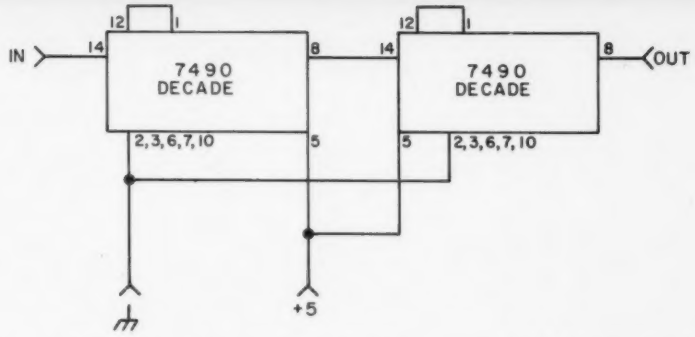
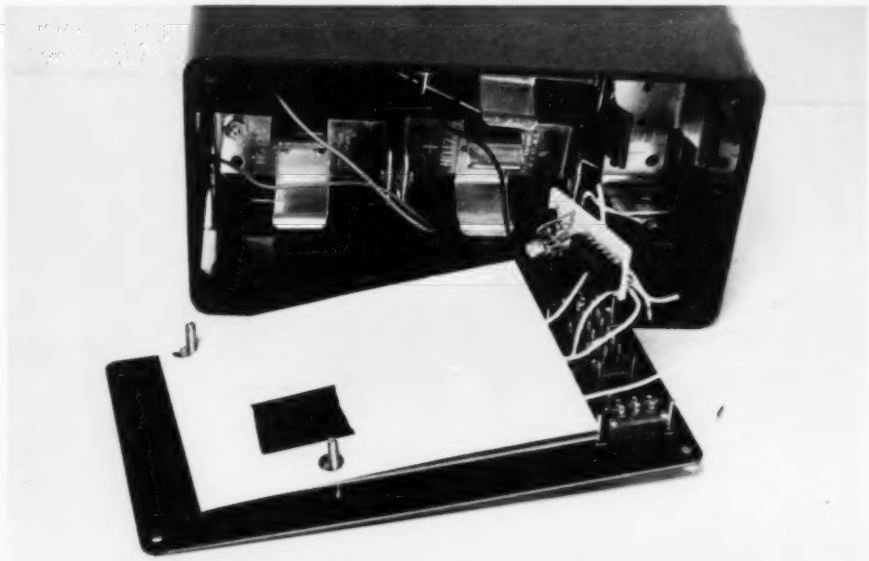
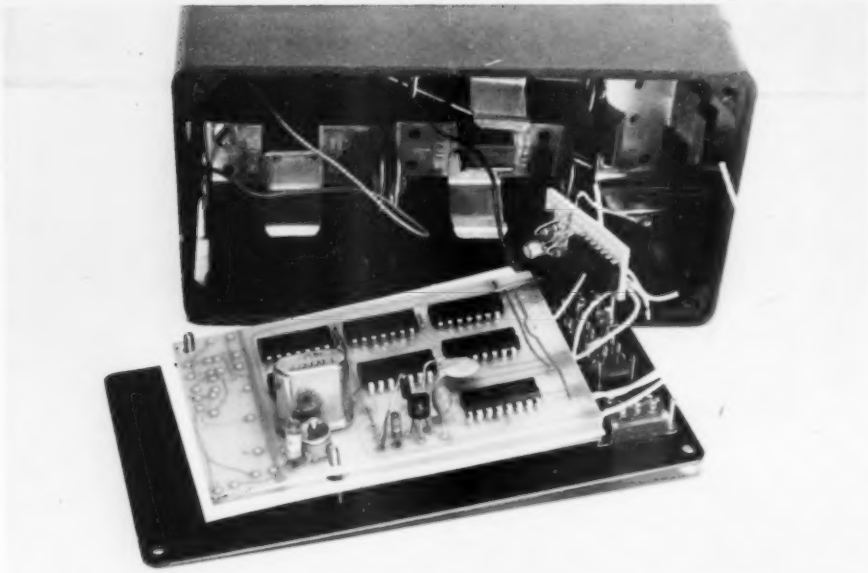


Fig. 4. Schematic diagram of the divide by 100, one second extender circuit. This circuit allows the counter to look at signals in the hundreds of cycles range and provides readout to 1 Hz.

The reset circuit built for the Handi-Counter works like this: When the enable signal goes active to allow the counter to count the input signal, a very fast RC differentiating network creates a narrow spike that resets the stages. You can see that since this spike occurs because of the enable signal, it actually resets the circuits when they are supposed to be counting. This is no real problem at slow speeds, but at higher



This photo shows the details of the piece of 3" x 5" file card, reinforced as mentioned in the text. This card insulates the timebase and the 3 DCU.



This shows how the timebase board is mounted. Note that there are no components at the top of the board. The top of the board is reserved for the power supply parts which are not used with the battery supply.

speeds, if the reset pulse is very wide, it can knock off a pulse or two and give an inaccurate reading. For the 10 us signal knocking a few pulses off can throw the MHz readout way off. In most counters that use this method, they merely adjust the clock signal so that the counters are enabled a little longer, but few of those counters use a gating signal of only 10 us, so that's why we have the two reset signals.

The counter input amplifier shown is pretty sensitive. Although I never measured the sensitivity, it works well just picking rf up with a little wire antenna. Its major problem is that you can blow the FET pretty easily. So be careful about input signals.

To calibrate the counter you can use a known accurate signal, or beat the oscillator against WWV. I prefer the first method because there are some pretty whacky beat notes because of the frequency division and some are only a hundred Hz away from the main signal.

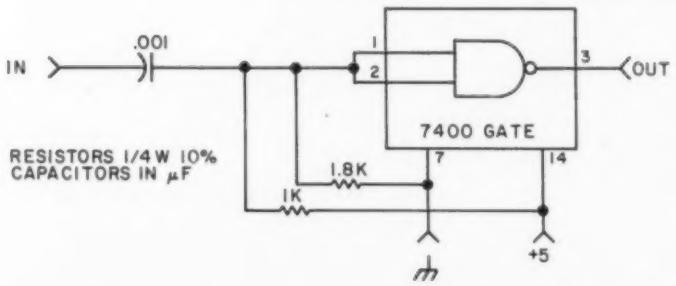


Fig. 5. Reset generator schematic. This added circuit provides a reset for the counter in the low speed (1 Hz) readout position.

Construction

Building the counter is really not hard. Obviously, the first step is to collect all the parts, then do the layout of the front panel of the case, and finally, mount the pieces in the box. You can use any box for your counter; I wanted the hand-held size and battery power so I obtained a 2¼" x 3" x 6" black box from a local supplier and tried almost in vain to paint on some kind of trim. If you can obtain one of these, get one with an aluminum front panel — it is easier to paint, cut and work, than the phenolic one that I bought. From all the photos, you can see how and where I put the switches. The key to switch mounting is to keep the switches out of the way of the 3 DCU and timebase circuit boards. These photos do not show the input jack and the sensitivity control; I mounted them on top of the case later. You will probably want a jack for charging your nicads without removing the cover from the box. If you decide to make your unit non-battery-powered, you will still have a lot of room in a box this size because all the power supply components mount on the top of the timebase PC board, and the transformer is small enough to sit on the bottom of the case.

Mounting Batteries

The bottom of my box wasn't flat; it had

some design raised in there, presumably to add strength. This was a problem in mounting the batteries and I ended up being able to get only one bolt through each holder and that only thumb tight. That only allows the batteries to stay in place, and offers very little strength against dropping, etc. You can see how the batteries are mounted from the photos. They are mounted to leave a "cavity" so the crystal, which sticks into the case pretty far, has room to keep from getting crushed. This cavity also makes a convenient place to put the three external circuit boards.

The battery mounting bolt leads stick out of the bottom of the case to mess up the effect of the little "feet" on the box. It is easy enough to glue flat grommets to the bottom, with the hole over the bolt heads for better feet than were on the box in the first place. Note: Later experiments showed that it is easier to buy a plastic 4-C cell holder and use it. The holder mounts in a smaller space than the individual cell holders and there is plenty of room for the crystal and external circuits. An added benefit is that the holder is cheaper than four of the individual units.

Building the Circuits

It is easy to build the kits; all the instructions are included. Trim leads very close to the PC boards. While the kit instructions do not stress this, we are going to mount the PC boards back-to-back under some pressure and we don't want any extra long or sharp leads sticking out of the boards. I recommend you even trim the leads on the crystal.They don't mention it in the kit, but it helps in sandwiching the boards closer together. Also take care in running the external wires on the board. They should be laid out so that they do not cross any pins or leads on the back of the board. Under pressure, these can puncture the insulation on the wires and cause a short. If you are using a different physical approach and have plenty of depth in your box, use the mounting method described with the kits and you eliminate many of the aforementioned problems.

Building the Input Circuit

The input circuit is built on a phenolic board, although you can make a tiny PC board for it if you want. Or, if space is at a premium, you can get the timebase extender board that comes in kit form from TWS; it is roughly 2" x 3" and has all three of the external circuits right on the one board. You can see the layout of the input circuit in the photos that show the inside of the box. In the photos it was mounted near the input

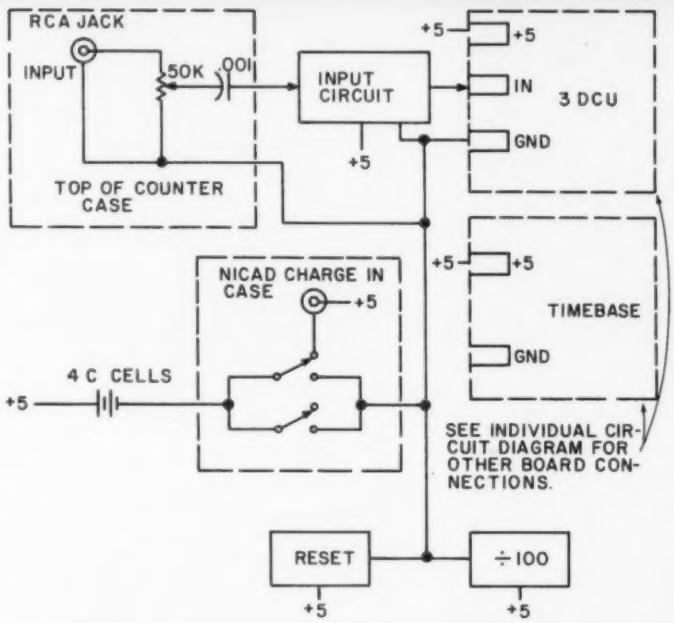


Fig. 6. Major power hookups and input circuit hookup. Note the nicad charging circuit. With a power supply (charger) plugged in, the nicads will charge when the unit is off. You may wish to allow them to charge at all times. If you use the power supply supplied with TWS's kit, you turn the unit on and off by cutting the ac from the ac cord to the transformer input.

selector switch, while in the final version, longer wires were added and it fit in the cavity formed by the batteries, and near the input level control and input jack. Make sure your wires are long enough to put it where you need it. There is enough hookup wire with the kit for most installations. After the circuit is built, put some tape on the bottom of the board so the circuit will not touch the battery holders or the other circuits that are stuffed along with it in the battery cavity. Fig. 3 is the schematic of the input circuit.

Divide by 100, Extender Circuit

The 10 ms clock from the kit drives this

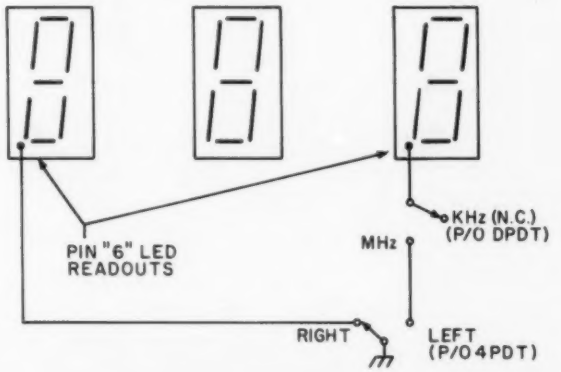


Fig. 7. Decimal point wiring diagram.

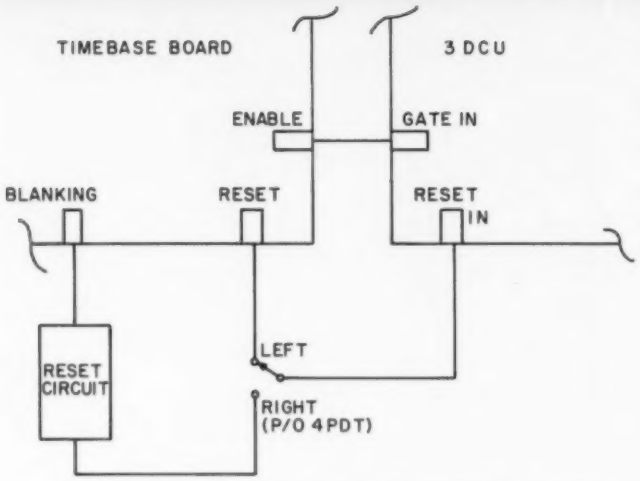


Fig. 8. Reset circuit hookup to the timebase and 3 DCU boards.

circuit shown in Fig. 4. The output of the divide by 100 circuit is one second clock used in the timebase generator to make the one second enable signal for the counter. The circuit is very simple, and consists only of two decade dividers in series. There is a photo of the perfboard layout for your reference.

Reset Generator

The reset generator is very simple; it consists of the RC network and a 7400 gate used as an inverter. Fig. 5 is the schematic of the circuit. The output of the gate is a normal logic 0. When the sample signal comes along (actually the inverse of the signal called the "blanking" signal with the kit), it causes a positive pulse output and resets the counter stages. Because of the nature of this reset, as mentioned before, it is best not to use it (use "kHz left") when looking at very fast signals. On slower signals, there will be no difference in reading between this and the "MHz right" readings.

Interconnecting the Circuits

Fig. 6 shows the major interconnections and the hookup of the input circuit. First mount the 3 DCU counting and display unit on the front panel as shown in the photo, then run the power and interconnections as given in Fig. 6. Run 1 inch wires from the terminals on the 3 DCU card; these will connect later to the switch and the timebase board. Run the decimal point wiring to the switches on the front panel as shown in Fig. 7.

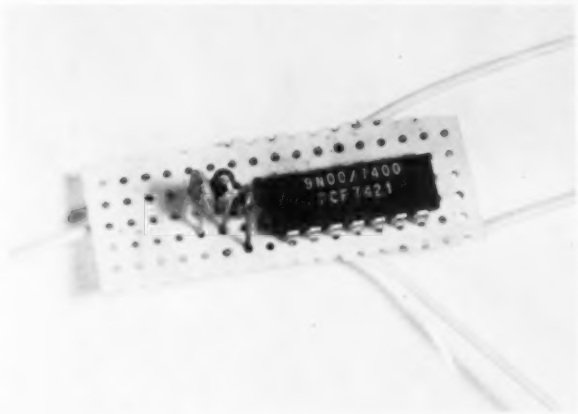
Fig. 8 shows how to connect the reset circuit to the timebase and 3 DCU boards. Fig. 9 shows the hookup for the interconnecting wiring that does the timebase switching, including the divide by 100 circuit.

When the wiring is completed, put an insulating card (a piece of 3" x 5" file card works great) between the 3 DCU and the timebase card as shown in the photos. First mount the whole thing up and tighten down the mounting bolts. Then take the thing apart again and inspect the piece of card for punctures where a wire from the circuit board was too long or too sharp. Trim the faulty wires or pins, reinforce the card with a black electrical tape strip around the puncture (if any), add another layer of insulating card, and remount the boards.

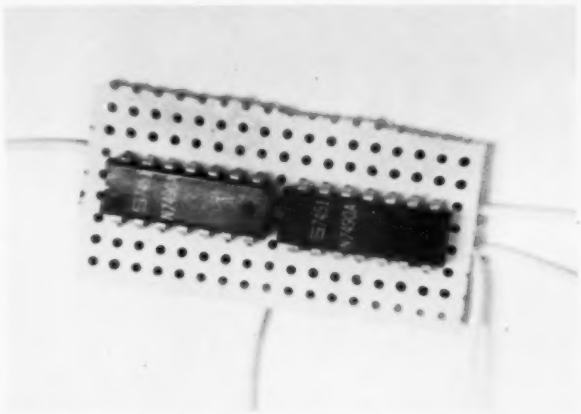
Put in the batteries, drop the input circuit, divide by 100 and the reset circuit boards in the cavity. Oh, and don't forget to install the input jack and pot. Wire the power connections to the batteries, and let 'er rip! The displays should light.

Checkout

When power is applied, the readouts may show any number reading at all. This is



This is the perf board-mounted reset circuit.



The divide by 100 circuit — it provides a one second clock for the Handi-Counter.

normal. After a second or two, and the oscillator is running and all the circuits "settle," the random numbers should clear. The display should flash "000." Now you are ready to use your counter and look for all manner of signal around the shack. Make sure the thing resets in all switch positions and you can tell if your new reset circuit is working okay.

Points to Remember

The unit will only run for a couple of hours from fully charged nicads, so don't leave it sitting around "power on" unless you are using it. The crystal oscillator is extremely stable and will work with little or no warm-up so don't worry about leaving the power on. Build a nicad charger[1,2] and keep the nicads fresh. Some will want a trickle charger that will always keep the unit "ready to go." You may want to build up the power supply external to the unit, let it trickle the nicads (there is 8 V unregulated in there), and use it for operating around the shack. You can also use cigarette lighter power by using a suitable dropping resistor. For that purpose, it is possible to use the regulator circuit and either positive or negative ground 12 volts. Instructions for mobiling come with the kit. Your resistor value will be different because of the extra current and IR drop caused by the added circuits.

This is one of the handiest pieces of test gear I have. And it cost very little, is very "state of the art" and requires no test equipment to build. I hope you enjoy building and using the Handi-Counter with its 3 x 6 digits and eight digit capability. ■

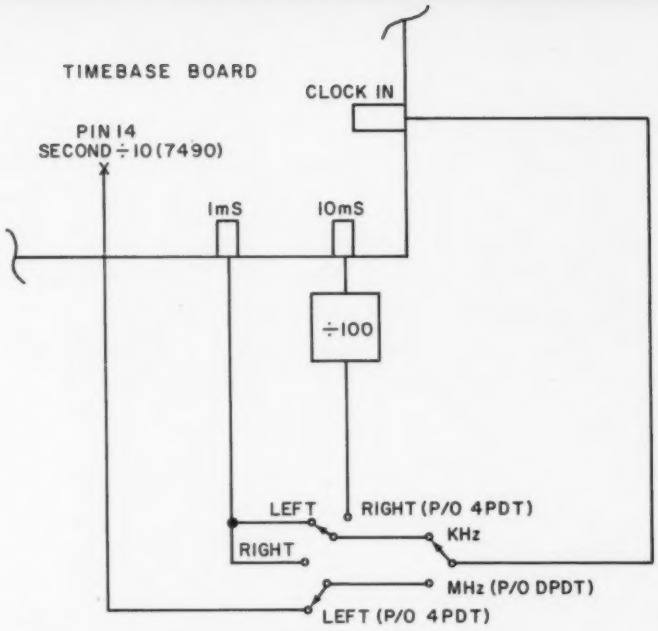
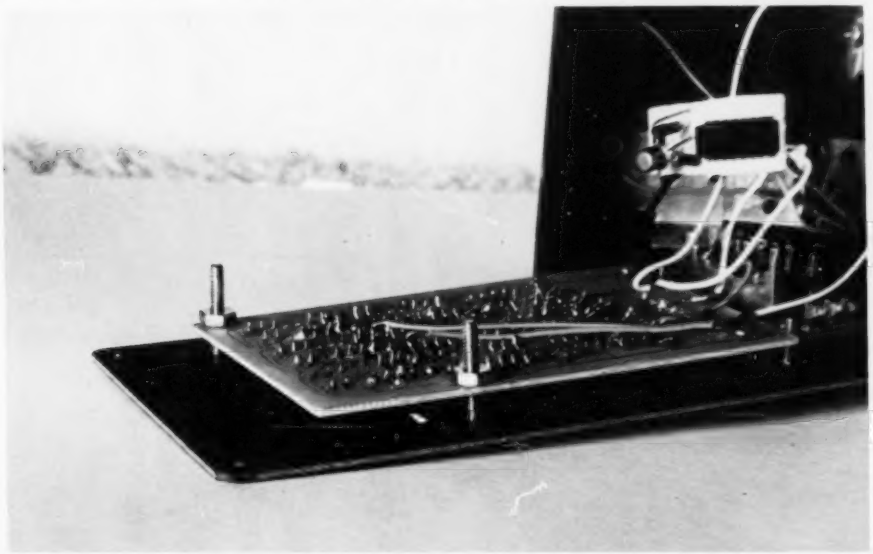


Fig. 9. Timebase switching diagram. Note that 1 ms is used on both MHz right and kHz left. The difference is the decimal point, and the source of reset pulse. (See other figures for details.)

References

[1] "Nicads, A Shocking Exposé," Bob Thornburg, *73*, Apr., 1975, p. 51.
[2] "How to Make Nicads Behave," Peter Stark, *73*, Dec., 1974, p. 24.



Here is how the board is mounted on the front panel. Just snug the nuts on the mounting bolts down enough to hold the 3 DCU board in place and let the front of the readouts and ICs hold the pressure against the front panel.

How to Become a Troubleshooting Wizard

by
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Arlington VA 22203

In times past just about every amateur acquired, if only out of sheer necessity, some degree of troubleshooting acumen. Of course, it might be argued that rigs of those bygone days were a lot less sophisticated than rigs of today. Is that single fact really good reason for the seeming decline in general amateur troubleshooting ability? I think not. It is contended here that anyone with a knowledge of theory deep enough to pass the General class license examination can make a reasonably good attempt at troubleshooting. Of course, years of experience are needed to make a commercial troubleshooter but we are only concerned with maintaining the usual ham's station equipment and not how many high technology transmitters or receivers he can fix per day or week.

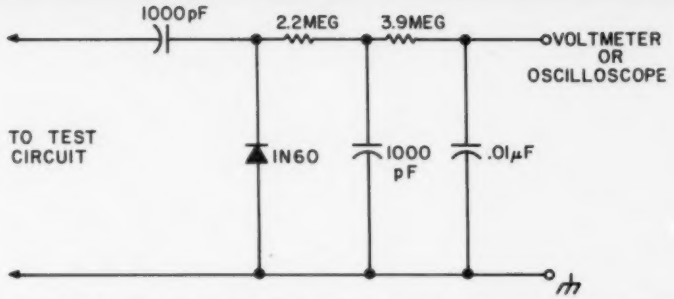


Fig. 1. Schematic of an rf demodulator probe for voltmeter or oscilloscope.

Crux of the Problem

Lack of familiarity and zero technique are two reasons why, to many, troubleshooting is troublesome. Consider a case in point. I have a friend who bought a "near-new" condition Novice CW transmitter for a song ($5) because the now-General former owner found out (after the new license arrived) that it wouldn't work on 20 meters. He even knew what the main symptom showed – no grid drive to the final on 20 meters. All other bands worked fine. My buddy, mind you, was not an experienced troubleshooter at that time. He was merely a thoughtful teenaged amateur. He reasoned that a loss of drive on any single band in a standard simple MOPA transmitter had to be either an open coil (on that band) or some defect in the band switch. In this case the wire on the band switch that went to the 20 meter tap on the grid tank coil was not soldered properly! This little story points out one main thing that will allow successful troubleshooting: Think out the problem ahead of time with schematic in hand, to ascertain all possible causes.

Test Equipment Needed

After working in a lot of service shops, I have grown weary of the fellows who use the excuse that they could "fix it themselves if only they had the equipment." While a bench loaded with expensive laboratory grade test equipment is desirable, it is not strictly necessary for most troubleshooting. Sure, if you were in the business of providing electronic service for a profit, it would be a justified purchase because of the time savings on each job. The average amateur, though, only wants to get back on the air without having to wait weeks for a repair shop's turnaround time to elapse.

What constitutes "necessary" equipment? Consider, first, that the most valuable and versatile piece of "test equipment" is already in your possession: your head! The mind can only function, however, when given a data input concerning the problem to be solved. For this we need our learned observations about the performance of the rig vis-à-vis the defect and some basic measurements, many of which can be taken with low cost or even simple home brew instruments.

Most basic in the troubleshooter's arsenal of instruments is some sort of multimeter. I prefer the traditional Volt-Ohm-Milliammeter (VOM) over the Vacuum Tube Voltmeter (VTVM) in those cases where money or other considerations dictate that only one instrument be purchased. It is wise to purchase an instrument with a sensitivity of at least 20,000 Ohms/volt (higher if possible). There are at least three reasons for this preference: portability, existence of a current range and insensitivity to rf fields. Many of the modern FET voltmeters fill the bill in the first two requirements (often better than the classic VOM) but most sadly fail in the third: They will read in error around rf fields such as exist in your transmitter.

Years of experience are needed to make a commercial troubleshooter, but we are only concerned with maintaining the usual ham's station equipment . . .

The classic VOM will have ac and dc voltage scales, at least one current range (usually more) and at least one resistance

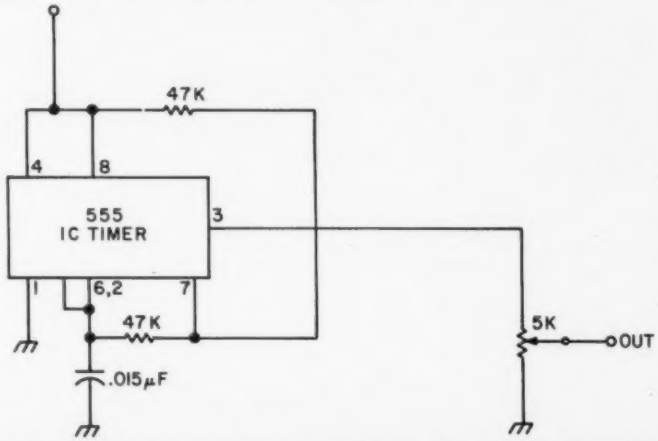


Fig. 2. 1000 Hertz square wave generator produces harmonics useful for signal tracing from audio to several MHz.

range. As is usual, the more you can pay for a VOM the more features and ranges you can expect. You can extend the dc voltage scale of most instruments well into the kilovolt range by the use of an external high voltage probe of the type which has a built-in divider network. It is also possible to get at least a relative rf level indication through the use of a demodulator probe such as that shown in Fig. 1. Most manufacturers offering such probes claim operation well into VHF.

One main thing that will allow successful trouble-shooting: Think out the problem ahead of time with schematic in hand, to ascertain all possible causes . . .

The VOM is one of those "every ham should have . . ." instruments. Another in that category is the dip oscillator called "grid-", "base-", "gate-" or "tunnel-dipper" depending upon design. These instruments have an incredibly varied range of applications around a ham shack. They can be used to find the resonant points in tuned circuits, antennas and so forth. They can also be pressed into service as an absorption wavemeter, oscillating detector or impromptu signal generator. Best of all, they are simple to build and are low cost regardless of whether obtained in kit form or built from scratch.

In many troubleshooting procedures it might prove desirable to use a controlled, locally generated substitute signal. These are best supplied by a signal generator. Of course, a lab-grade instrument is the preferred type. It must be noted that many high grade signal generators are available on the used and/or surplus markets. While it might be "nice" to own a fine signal source, a more modest instrument will suffice for fixing the rig. It is necessary to keep in mind that "troubleshooting" and "alignment" are different procedures and that the signal generator requirements are vastly different. Commercial servicers have little trouble justifying a kilobuck signal generator for alignment purposes. They need the superior short term stability and a high quality attenuator; you don't. A "service grade" signal generator will be a very useful tool in ham troubleshooting. These are not up to the lab grade types in performance but they can be had for less than a month's rent on the big gens!

A crude form of signal generator useful for troubleshooting is shown in Fig. 2. This is a square wave generator operating at about 1000 Hz. Such circuits are widely used in the service industry because they can help pin point a dead stage in moments. These "instruments" generate the fundamental square wave and a boat load of harmonics that can be used out to several MHz. In most amateur work this means that we can "quick check" the audio, i-f and rf (on 160 to *maybe* 40 meters).

Your crystal calibrator may also suffice as a troubleshooting signal generator. In Fig. 3, we have a circuit that can be home brewed from low cost TTL digital ICs. Although the possible choices of output frequency are limited in this case you can obtain almost any frequency by correct choice of oscillator crystal and/or division ratio. If zeroed against a frequency standard such as WWV, this circuit can serve as an accurate method for frequency measurement. It can also be used as a regular signal generator or as a type of device shown in Fig. 2. In those latter applications it would be wise to provide an attenuator.

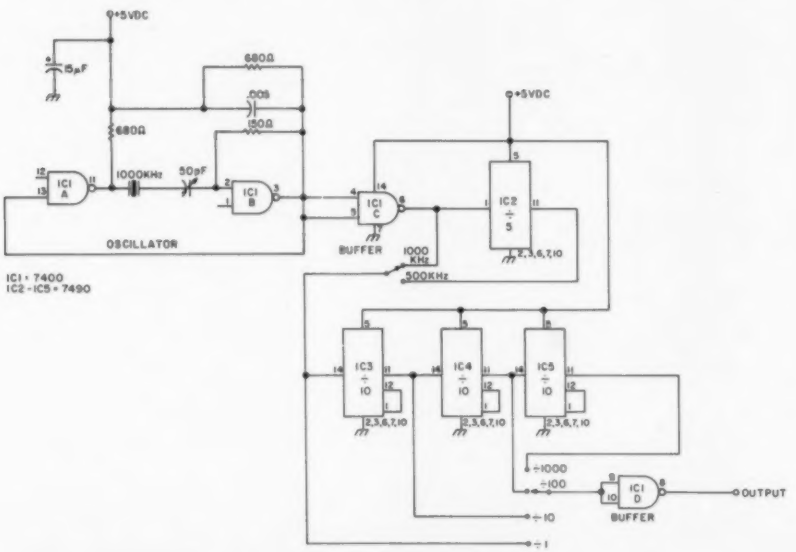


Fig. 3. Schematic of a TTL crystal calibrator.

If a smart troubleshooter were to be allowed only one instrument he would choose the oscilloscope. If triggered sweep and dual beam can be afforded, it would be very useful. Prices on 'scopes vary from $5/free to several kilobucks depending upon features, condition and vintage. I have seen many oscilloscopes, some quite nice, remain UNSOLD for lack of interest at hamfests and auctions!

Servicing typical ham transmitters requires several special instruments. Most of them are the sort which I feel ought to be in every ham shack. One item is the 50 Ohm dummy load. At a cost of only a few bucks you can have a dummy antenna which will absorb all the power you have a right to be dishing out to a real antenna. Only the utterly irresponsible would attempt to service a transmitter connected to a "live" antenna!

Rf wattmeters and relative field strength meters (Fig. 4) are also amongst the highly desirable. Although I prefer the wattmeter sort of instrument, make no mistake about it, the old fashioned swr bridge does have a lot of good mileage left.

No one seriously expects an amateur to be as well equipped with test instruments as a commercial or factory level shop. He should, however, attempt to obtain those considered "basic." For some of the others he might work through the local club to build a test gear collection of really nice pieces or arrange with certain locals to split the load by having each fellow buy certain instruments and then do a lot of "lendin'."

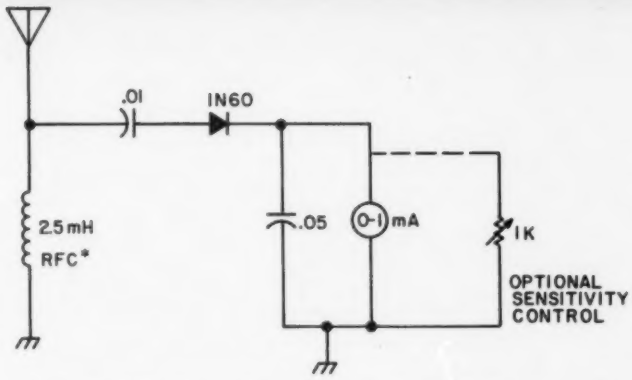


*Fig. 4. Schematic of a simple rf field strength meter. (*Can be replaced by an LC tank circuit for greater sensitivity or use as an absorption meter.)*

Troubleshooting Procedure

Troubleshooting involves a logical, step-by-step procedure for determining a fault in a piece of equipment. Best results in a minimum of time are obtained by using a method formed from a logical analysis of the problem at hand.

One thing which makes troubleshooting a darn sight easier is a service manual (or AT LEAST a schematic) on the equipment. It is the wise amateur who obtains (even at a ridiculous cost) the service manuals for all of his station equipment. In most instances new equipment comes with a manual; keep it. If you buy used or for any reason are without a manual, buy one and keep it on file. Do not expect your rig's manufacturer to be

The most valuable and versatile piece of "test equipment" is already in your possession: your head!

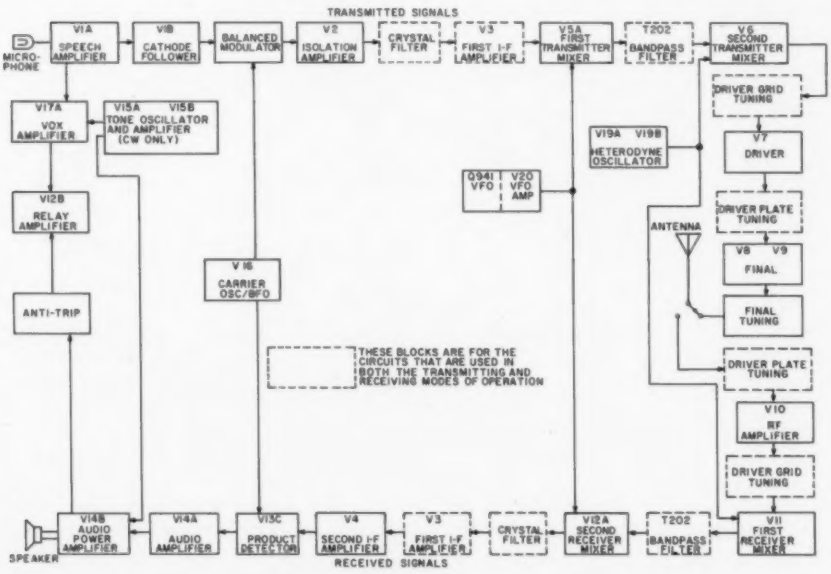


Fig. 5. Block diagram of a popular transceiver. (Courtesy of Heath)

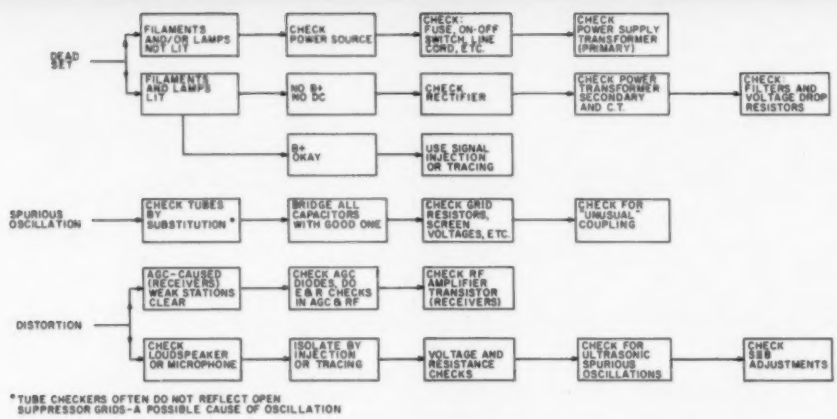

DEAD SET
FILAMENTS AND/OR LAMPS NOT LIT
CHECK POWER SOURCE
CHECK: FUSE, ON-OFF SWITCH, LINE CORD, ETC.
CHECK POWER SUPPLY TRANSFORMER (PRIMARY)
FILAMENTS AND LAMPS LIT
NO B+ NO DC
CHECK RECTIFIER
CHECK POWER TRANSFORMER SECONDARY AND C.T.
CHECK FILTERS AND VOLTAGE DROP RESISTORS
B+ OKAY
USE SIGNAL INJECTION OR TRACING
SPURIOUS OSCILLATION
CHECK TUBES BY SUBSTITUTION *
BRIDGE ALL CAPACITORS WITH GOOD ONE
CHECK GRID RESISTORS, SCREEN VOLTAGES, ETC.
CHECK FOR "UNUSUAL" COUPLING
DISTORTION
AGC-CAUSED (RECEIVERS) WEAK STATIONS CLEAR
CHECK AGC DIODES, DO E & R CHECKS IN AGC & RF
CHECK RF AMPLIFIER TRANSISTOR (RECEIVERS)
CHECK LOUDSPEAKER OR MICROPHONE
ISOLATE BY INJECTION OR TRACING
VOLTAGE AND RESISTANCE CHECKS
CHECK FOR ULTRASONIC SPURIOUS OSCILLATIONS
CHECK SSB ADJUSTMENTS
* TUBE CHECKERS OFTEN DO NOT REFLECT OPEN SUPPRESSOR GRIDS—A POSSIBLE CAUSE OF OSCILLATION

Fig. 6. Troubleshooting tree useful for finding a good jumping off point for troubleshooting specific defects.

able to supply manuals indefinitely; get yours now.

One significant aid in troubleshooting is the block diagram. It is especially useful in rigs such as transceivers where a single stage might have different functions. An example of a block diagram, this one from the popular HW-101, is shown as Fig. 5. You can often cut the work of troubleshooting in half by doing a "desk check" of the service manual and block diagram before reaching for instruments to do the "bench check." Note that many of the stages, shown here in dotted lines, are common to both transmit and receive functions. Although there are exceptions, you can usually overlook these stages when a defect affects only one function or the other.

The "screwdriver technician" is the bane of professional servicers everywhere . . .

The element of logic in troubleshooting should be almost an *a priori* truth (despite the philosophers who say that such cannot exist!). After all, if the set is dead (no lamps or tube filaments lit) is it wise to worry about, say, the beat frequency oscillator? Fig. 6 shows what is affectionately called a "troubleshooting tree." Although this is not offered as a universal approach you can often at least get onto the right track by its use; it is intended only to be a "point of departure guide."

Two terms pop up a dozen times in any servicing literature: signal tracing and signal injection. They are basically methods for locating a dead or otherwise defective stage. Before beginning one of these procedures, however, make certain preliminary observations. For example, can you hear noise in the speaker as you rotate the volume control? If so, the cause of the dead condition is probably PRIOR to the volume control. What about dirty contact noise as you rotate the selectivity switch? This usually means that the fault is prior to that point. Band switch noise (again, as you change bands) could mean a fault in the rf or a dead local oscillator. What about the level of "background" hiss (you know, as if you were tuned to a dead band)? High noise levels may tend to indicate troubles in the rf amplifier or antenna circuit. Here is one point where your calibrator is useful. Note how high the "S-meter" reads when the set is working normally. When a defect occurs, turn on the calibrator and see if it is lower. If not, suspect the antenna or feedline. These observations are of the sort that can save an awful lot of time. Most pros use them all day long even when unaware; it is the source of their supposed professional "intuition."

The process of signal tracing involves injecting a known and controlled signal at the input to a chain of stages, then looking for it at the outputs of successive stages with a demodulator equipment signal tracer (high gain audio amplifier with a fancy name!) or oscilloscope. When you find the defective stage, you can then use the VOM or VTVM to locate the bad part. In some cases, you might want to inject an appropriate signal at the antenna terminals while in others it might be better to inject another sort of signal at the input of the i-f strip.

Signal injection is a similar process. In this method you start at the output and inject an appropriate signal into the inputs of successive stages until you find one which no longer is capable of producing an output. In signal injection you begin at the output and work toward the input, while in signal tracing just the opposite situation obtains. In either event the procedure can usually be expected to ferret out the defective stage. Once found it is usually a simple matter to dig out the voltmeter and determine which component is at fault. Be sure not to overlook the obvious fault such as a bad tube or a loose connection. Once again, the

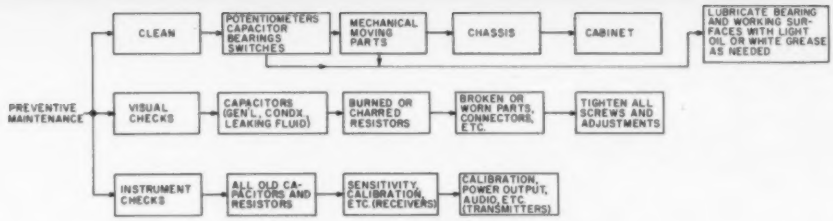

PREVENTIVE MAINTENANCE
CLEAN
POTENTIOMETERS CAPACITOR BEARINGS SWITCHES
MECHANICAL MOVING PARTS
CHASSIS
CABINET
LUBRICATE BEARING AND WORKING SURFACES WITH LIGHT OIL OR WHITE GREASE AS NEEDED
VISUAL CHECKS
CAPACITORS (GEN'L. CONDX. LEAKING FLUID)
BURNED OR CHARRED RESISTORS
BROKEN OR WORN PARTS, CONNECTORS, ETC.
TIGHTEN ALL SCREWS AND ADJUSTMENTS
INSTRUMENT CHECKS
ALL OLD CAPACITORS AND RESISTORS
SENSITIVITY, CALIBRATION, ETC (RECEIVERS)
CALIBRATION, POWER OUTPUT, AUDIO, ETC. (TRANSMITTERS)

Fig. 7. Preventative maintenance tree.

observant are usually a bit more successful.

When troubleshooting transmitters, you can use a demodulator probe to find relative rf levels on the 'scope or VOM. It is usually better, though, to read the dc voltage developed by the grid leak bias often used in transmitter stages. This voltage will be proportional to the rf level delivered by the preceding stage. This system works so well that it is the basis for the Motorola "test set" popular with FMers who run surplus commercial Motorola mobile equipment.

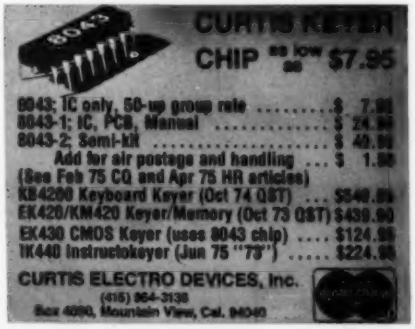
Alignment

The most exasperating mark of the neophyte troubleshooter is a wild "diddle stick" (alignment tool). It is a pretty good rule to assume that alignment points NEVER shift enough to cause a gross fault in the receiver, especially a sudden fault. The only real exception is the local oscillator. Even in that "sometimes" case there are other methods (i.e., measure the frequency) for determining its condition. One telling thing that shows whether or not the stage is actually oscillating is to measure either the grid bias or the voltage drop across the emitter resistor as the set is tuned through the range (or in the case of crystal oscillators remove the rock). This will cause the bias to change suddenly for crystal pulling or smoothly in VFO type circuits. DO NOT EVER touch an internal alignment point without good reason, proper equipment and a knowledge of what it is that you are doing. You can diddle stick a decent set (that really only needed a small component) to death! This is why the "screwdriver technician" is the bane of professional servicers everywhere.

Preventative Maintenance

There are a number of little tasks which will keep your rig in top shape for a lot of years. These generally fall under the heading of "preventative maintenance" – see Fig. 7. One task would be to check all tubes on a periodic basis, say every six months or maybe once a year. Replace those which are defective or grossly weak. Some advocate doing a voltage check at critical points throughout the circuit especially in the power supply. It is recommended that you clean the inside of the rig, including all circuitry, with a paint brush and a mild solvent where needed. Use a switch/control (also called "tuner") cleaner spray on all band switches, function switches and controls. Clean capacitor and rotary switch bearings and relubricate using a white grease such as "Lubriplate." "Peaking up" alignment is NOT part of this procedure unless you can perform factory-level service. Even in that case it should not be obligatory except every few years. I know it sounds like harping, but alignment is simply not all that common a problem. In fact, after fifteen years of experience, I can only remember a couple of cases where alignment was genuinely needed (except where somebody played) and these were new and in-warranty sets! ■

A number of little tasks which will keep your rig in top shape for a lot of years fall under the heading of "preventative maintenance" . . .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Module Kits- A Low Cost Homebrewing Breakthrough

by
G. R. Allen W1HCI
80 Farmstead Lane
Windsor CT 06095
and
Bob Brown W2EDN
93 Gilmore Avenue
Binghamton NY 13901

With the high rate of inflation, it is more and more difficult for the average ham to afford a factory wired piece of gear for the VHF bands. For that reason, the authors have developed a modular approach to building a VHF transceiver for the 144 MHz or 220 MHz bands. By using a modular approach, the builder is not required to lay out a large chunk of cash just to get on the air. The builder may build a

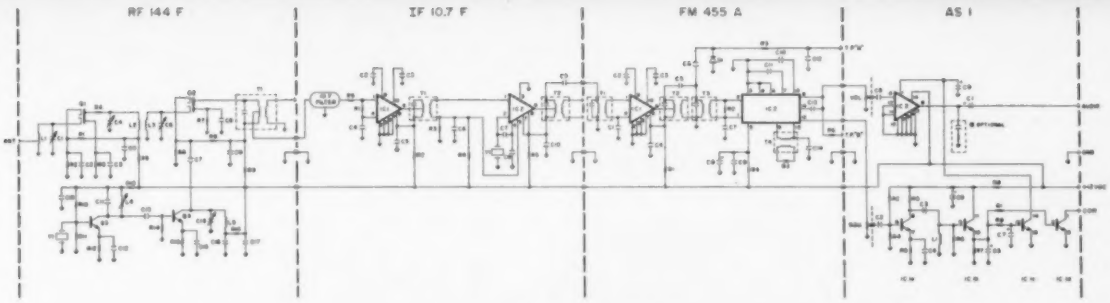


Fig. 1. RX 144 C schematic.

simple, basic transceiver and then add expansion modules and options as needs and finances dictate. Because of the fact that this modular approach requires the experimenter to build his own units, the experimenter will gain knowledge and knowhow and thus be able to maintain his own equipment should problems develop.

The transceiver described in this article may be built for either the 144 MHz or 220 MHz bands and will compare favorably to commercially wired units. The basic transceiver consists of a transmitter and a receiver operating as single channel units, and can be built for less than $100. Simple modules, such as multi-channel decks, channel scanner, and power amplifier, may be added to the basic transceiver to form a medium power, multi-channel, scanning transceiver for a cost well less than the commercially wired equivalent. The assembled transceiver may be operated on either 144 MHz or 220 MHz, depending on the kits purchased, and may be used in a breadboard fashion or mounted in a home brew or commercially available case. The builder may plan to construct the basic transceiver initially in order to get on the air for a minimum cost. At any time in the future the expansion modules may be added to multi-channel and/or provide higher power.

The units described in this article are designed primarily for 144 MHz and 220 MHz. The builder, however, will not be limited to these two bands in the near future. Currently, VHF Engineering has receiver modules available for 6 meters and is working on a 6 meter transmitter module. UHF 450 MHz transmitter and receiver modules have just become available.

It is impossible in a short article to give every construction detail required to exactly duplicate the transceiver described in the article. For that reason, basic schematics are provided for reference purposes only. Complete construction and debugging details are provided with the kits. Should the experimenter wish to build his transceiver from scratch, he may obtain boards and/or schematics and construction details from VHF Engineering for a nominal charge.

The Receiver

The VHF Engineering receiver kit used in this article is an RX 144/220 C. It may be used either on 144 MHz or 220 MHz merely by changing the coils on the front end rf board and by making a few minor component substitutions. The receiver draws 60 mA squelched and uses integrated circuitry exclusively except for the rf board. Sensitivity is .3 uV for 20 dB quieting for 140-170 MHz and .5 uV for 220-230 MHz. The receiver is dual conversion and is supplied with a 10.7 MHz 2 pole filter producing a 6 dB bandwidth of ± 10 kHz. The receiver will produce two Watts average audio output into a 4 to 16 Ohm speaker. The front end of the receiver uses a dual gate MOSFET for low susceptibility to intermodulation. The receiver kit is very easy to assemble, taking about 10 hours for the average builder. Alignment is done by using a signal generator, an rf probe, and a high impedance voltmeter (all borrowed, of course). Complete construction and alignment instructions are given with the kit.

By using a modular approach, the builder is not required to lay out a large chunk of cash just to get on the air . . .

Receiver Multi-Channel Option

The basic receiver is a single channel unit. It may be used as a single channel unit until such time as interest and finances lead to the desire for additional channels. When additional channels are required, the receiver can be multi-channeled simply by adding the VHF Engineering CD-1 multi-channel deck.

The CD-1 consists of a 10 channel deck complete with circuit board, sockets for the crystals, diodes, resistors and capacitors. Receiver channel switching is accomplished with a diode switching arrangement to permit manual switching of channels and automatic switching using the ten channel scanner. The completed 10 channel deck is plugged directly into the receiver as shown in Fig. 2. This receiver multi-channel kit is a

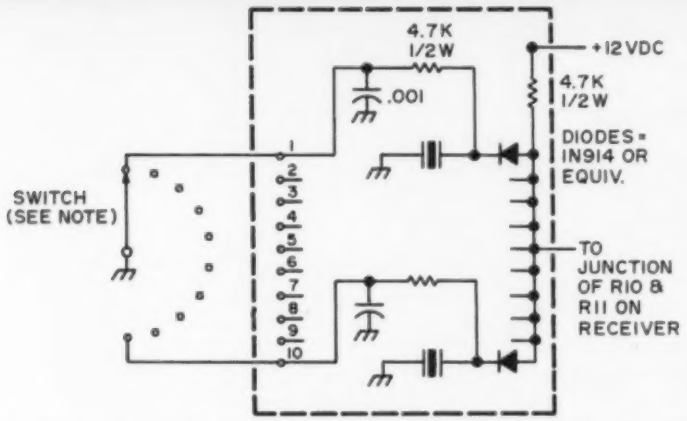


Fig. 2. Receiver multi-channel option. Note: Switch is part of transmitter multi-channel option.

versatile unit and may be used with most transceivers using crystals in the 45 MHz range.

Scanner Option

A channel scanner is a gadget extremely valuable to a true FM enthusiast, as it permits the operator to sequentially search selected channels for activity. All receiver channels are scanned automatically in sequence to see if a signal is present. If a signal is found, the scanner locks on the signal and remains on that channel as long as activity is present.

The circuit consists of a simple multi-vibrator operating into a decade counter and a decimal decoder. The output of the decimal decoder drives LED lights to indicate the channel being scanned. Switching diodes on the CD-1 multi-channel board are used to switch the crystals in and out of the circuit. A carrier operated relay connection is made to the receiver board to stop the multi-vibrator when activity is found on a channel. The circuit is easily defeated if manual override is desired. Either manual operation or automatic operation may be used.

The Transmitter

The transmitter is a true frequency modulated unit using crystals in the 12 MHz or 18 MHz range. It has an output of 1 Watt on 220 MHz and better than 1 Watt on 144 MHz. The only difference between the 220 MHz and the 144 MHz versions is the number of turns on the various coils. It is very simple to construct and may be tuned up by using a homemade rf probe and a small #12 bulb. Construction time is about 3½ hours.

Transmitter Multi-Channel Option

The basic transmitter is a single channel unit. While a single channel unit may be sufficient under some circumstances, the builder will very quickly require additional channels. The multi-channel option for use with the transmitter consists of a board, crystal sockets, and crystal trimmer capacitors needed to give the basic transmitter 10 channel transmit capability.

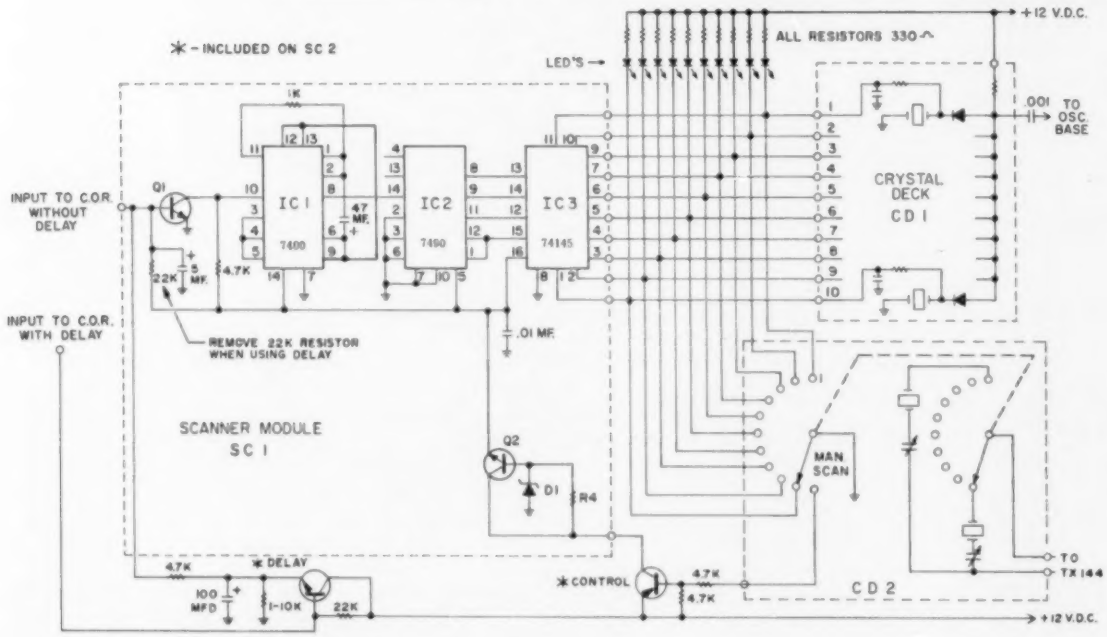


Fig. 3. Scanner option.

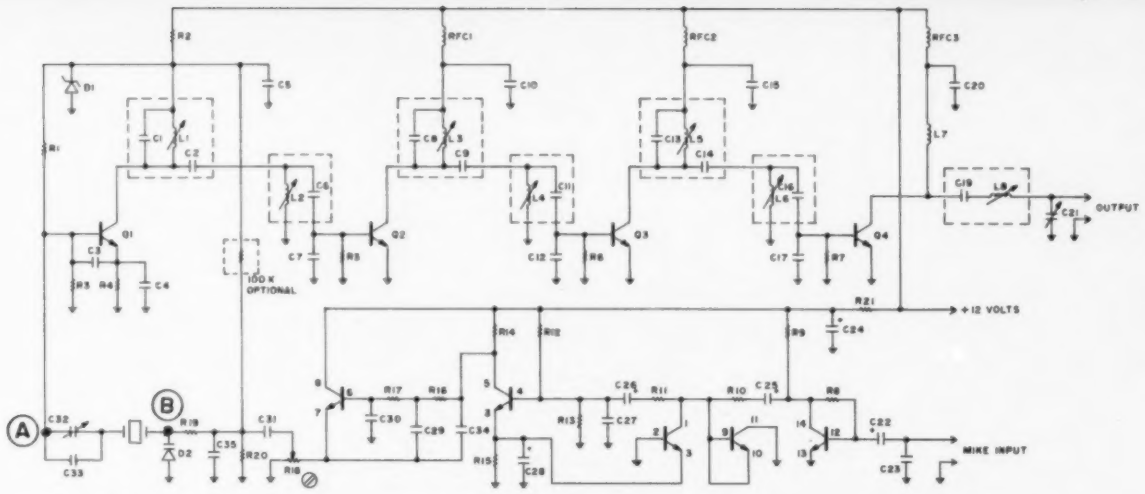


Fig. 4. TX 144/220 schematic. Note: Points A and B are connections for transmitter multi-channel option.

A multi-deck switch is provided for switching both the transmit and receive channels simultaneously. This unit is simple to build and may be constructed in about 20 minutes. Installation is shown in Fig. 5.

Power Amplifier

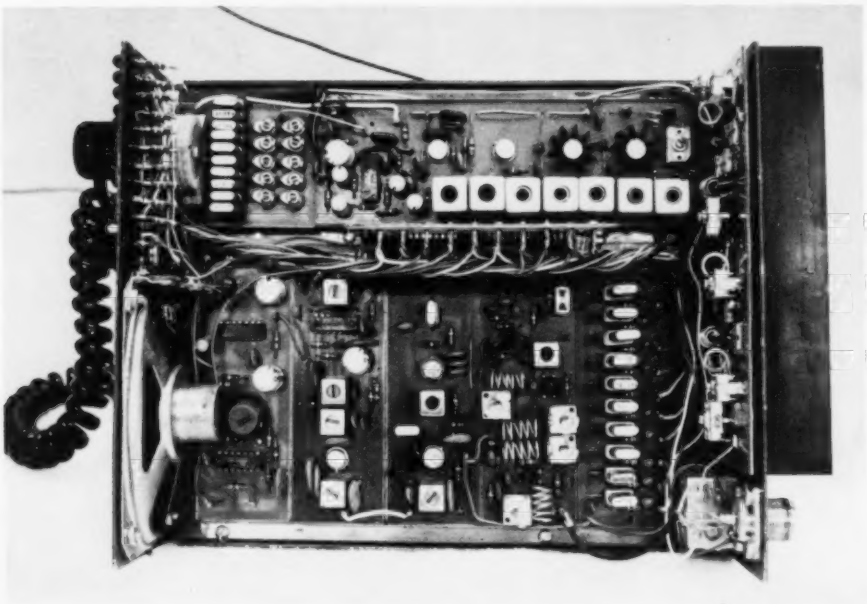
While one Watt may not seem like a lot of power, it is sufficient in most cases when the operator is using a repeater. In cases where direct operation is desired or where difficulty is encountered in hitting a specific repeater, a power amplifier may be desirable.

Two power amplifier options are available for the builder. Either the PA1501H or PA2501H may be used, depending on whether the operator prefers 15 W or 25 W. For the ten dollars difference in the price of the kit, I prefer the 25 W power amplifier. (Note that, for 220 MHz, only the 15 W amplifier is available.)

Both power amplifiers use two transistors in a broadly tuned common emitter configuration. Ratings on both units are conservative and the builder will most likely get appreciably more power out than the ratings indicate.

The Power Supply

A power supply is not needed for 12 V mobile operation, of course; however, it is a requirement for fixed station operation.



It's just poor practice with solid state equipment to give it the smoke test as a unit. Test everything individually to save time and trouble . . .

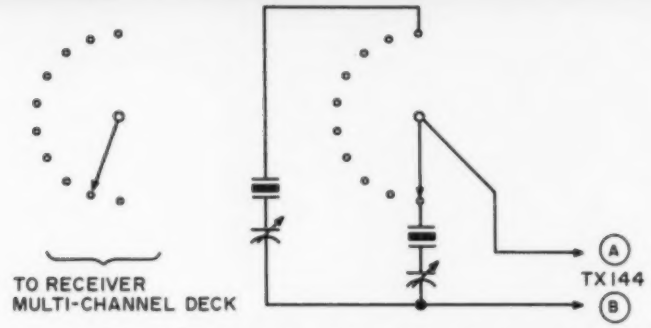


Fig. 5. Transmitter multi-channel option. Note: See Fig. 3 for receiver connections.

This transceiver is very rugged, and requires no special operating precautions other than keeping it out of the rain and away from direct lightning hits . . .

While an old car battery with charger may be used to supply the power for the transceiver, this is messy and inconvenient. The power supply used to power this transceiver (when used as a base) was the VHF Engineering model PS-12. It is rated at 12 Amps for 13.6 volts, which handles the transceiver and the 25 Watt power amplifier very comfortably. The power supply consists of a 550 voltage regulator chip driving two 2N3055 pass transistors.

Construction (See Photos)

A case with dimensions 9" x 7½" x 2¾" was used to house all modules. The size of the case is not critical, but the modules won't fit easily in anything smaller. The receiver and transmitter are mounted flat on the chassis as shown, using small standoffs to keep the boards off the chassis. The channel scanner is mounted vertically between the transmitter and the receiver. The power amplifier and transmit receive relay are mounted on the back panel along with the coax connector, the heat sink for the two power amplifier transistors and a small hole for the power leads. The multi-channel decks are mounted up front, with the switch shaft going through the front panel. The squelch and volume controls, the LED channel indicators, and a 2¼" x 4" speaker are mounted on the front panel.

Before mounting the completed modules in the case, it is important to thoroughly test each individual unit to ascertain that it has been wired correctly. It is just poor practice with solid state equipment to give it the smoke test as a unit. It is better to test everything individually to save time and trouble. Note that good instructions for test and debugging are provided with all kits.

Hookup

Interconnection of all components to make a complete transceiver is very simple as shown in Fig. 6. Number 14 stranded or solid wire or equivalent may be used for all power wiring. Good quality coaxial cable should be used for all rf wiring. Small diameter RG74/U may be used from the antenna relay to the receiver, while RG58/U may be used for the connections to the transmitter and the power amplifier. The relay used may be any double pole, double throw 12 V relay which will fit in the case you have selected. Contacts should be able to handle at least 3 Amps at 12 V and 25 Watts of rf at 148 MHz. VHF Engineering can supply this relay if you cannot obtain one locally.

A simple high pass filter consisting of a 22k resistor and a .022 uF capacitor in parallel is used in the microphone input to give better high frequency response for the transmit audio. Any 600 Ohm dynamic microphone may be used with the transceiver.

Operation and Performance

Several of the units as pictured in the photos have been used in the Binghamton, N.Y. area for quite some time now. The

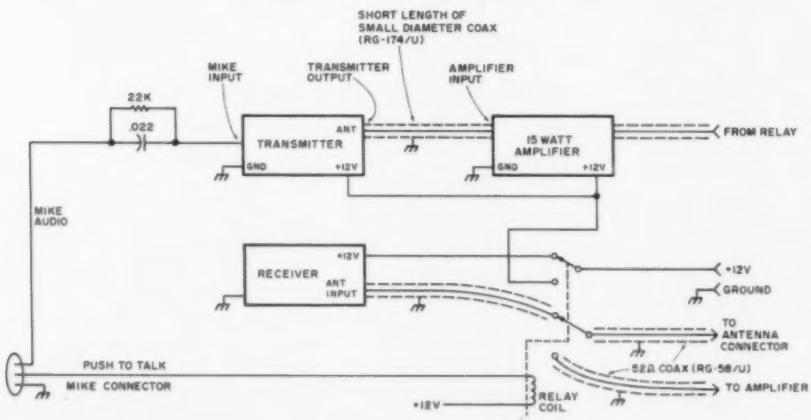


Fig. 6. Basic transceiver connections. Note: Relay may be any 12 V DPDT relay.

units have good audio on both transmit and receive and are virtually trouble free. Receiver sensitivity and selectivity are excellent when compared to most pre-wired commercially available units on the market. The transceiver is very rugged and requires no special operating precautions other than to keep it out of the rain and away from direct lightning hits.

If you ever check into the .22/.82 repeater in Binghamton, N.Y., the chances are good that you will work someone using a transceiver made from VHF Engineering products, and possibly one of the transceivers in the photos. Because of the simple modular approach and reasonable cost, you will also find a growing number of similar transceivers in use from coast to coast across the country. ■

Parts Lists and Board Layouts

Space does not permit the printing of complete parts lists and board layouts. To obtain parts lists, board layouts, and detailed assembly instructions, send $5.95 to:

VHF Engineering
320 Water St.
Binghamton NY 13902

Price lists for boards and complete kits are available on request.

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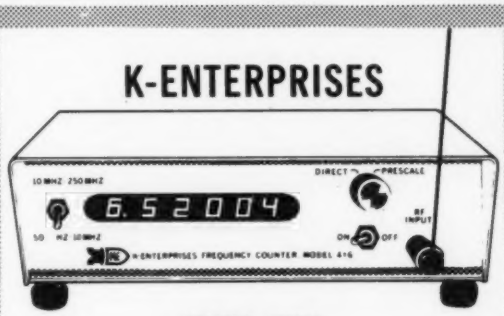

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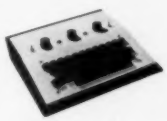

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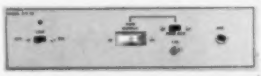

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What's All the Noise?

What is a good noise figure, 38-28-37? Oops! We are off on a tangent already and are getting way ahead of ourselves. Let us get back on the straight and narrow. First of all, what is noise? No, we are not talking about din but electrical noise. Static, for one, or atmospheric noise. Galactic (referencing galaxy) for another, or cosmic noise. Of course there is the ubiquitous man-made noise. Last but not least is thermal noise. This is the only noise used to compute noise factor. Thermal noise is circuit noise caused by thermal agitation of electrons.

Since all matter is comprised of electrons and only at absolute zero (-273° C.) are electrons quiescent, it follows that everything generates thermal noise. The higher the temperature an object is subjected to, the greater is the thermal agitation and consequently the greater is the thermal noise generated.

Starting with the antenna, it generates noise as does the coax, the antenna coil, the rf front end active device (tube, transistor, etc.) and as a matter of fact every component in a receiver does. This noise is added to the noise presented to the input terminals of the receiver and is amplified along with the signal. Noise introduced in subsequent stages does not get amplified as much and has little added effect. The overall gain of a good receiver can be 1,000,000 times voltage or 120 dB. 1 microvolt of noise introduced across the input terminals results in 1 volt of noise appearing across the output terminals. One microvolt of noise introduced after the rf stage is only amplified by possibly 100 dB and appears as only 0.1 volt across the output terminals. One microvolt of noise introduced in the i-f stages may only be subjected to gains of 10 dB to 90 dB depending on which stage generates the noise and has no appreciable effect on the output noise.

The noise introduced at the input terminals is subjected to the same overall gain as the signal is. The ratio of the noise measured at the output to the noise measured at the input is called the noise

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factor. A simpler way to express noise factor (more commonly called noise figure) is as a power ratio of the signal to noise ratio at the output as compared to the signal to noise ratio at the input. It is a ratio of two ratios expressed in dBs. A receiver with a 10 dB noise figure degrades the signal to noise ratio by 10X. A 5 to 1 signal to noise ratio at the input terminals becomes a 1 to 2 signal to noise ratio at the output. We have degraded from a signal 5X stronger than the input noise to one ½ as strong as the output noise. One would not be able to copy this signal. On another receiver with a 3 dB noise figure it will only degrade this same 5 to 1 signal to noise ratio of 2½ to 1 at the output thus still permitting armchair copy.

We can effectively change the signal to noise ratio of a receiver by adding a low noise preamp ahead of it. In essence you substitute the noise figure of the preamp for that of the receiver. The input terminals are now that of the preamp and not that of the receiver. That (ugh!) 10 dB NF (noise figure) receiver that we used for illustration before with a 2 dB NF (ultra quiet) preamp ahead of it is now effectively a 2 dB NF receiver. Let us keep in mind that the change works equally in reverse. A beautifully quiet 2 dB NF receiver with a (ugh!) 10 dB NF preamp ahead of it is now effectively a noisy pile of junk.

The noise figures used in the above examples were only illustrative. A 2 dB NF may be too expensive to be practically achieved in production. Much better than 2 dB NFs have however been achieved in the lab. I will settle for 3 or 4 dB anytime.

Noise figures are much more significant at VHF and at UHF than at HF. Try this simple test and convince yourself. Remove the antenna connector from an unsquelched VHF or UHF receiver and you will not hear any change in noise level. You may even find one that in fact goes up. This is caused by the input coaxial line removal unloading the input terminals permitting the input noise resistance to increase developing greater noise voltage across it. This will not happen with a properly designed input circuit. By removing the antenna connector from an HF receiver, however, you will find that the noise level drops considerably. The lower the receiver frequency the more pronounced will be the effect. At VHF and UHF most of the noise that we hear is

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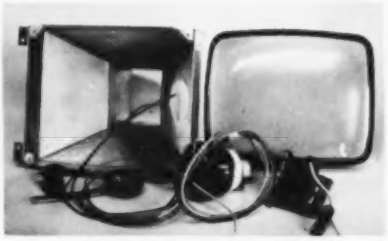
manifestly generated within the receiver as thermal noise. At HF it is mostly externally generated and represents galactic, atmospheric and man-made noise all picked up by the antenna.

If you have a relatively high NF VHF or UHF receiver, this does not mean that you will not be able to copy signals as full quieting. It simply means that you will require a stronger signal since your signal to noise ratio is lower. It is the fellow with the low NF receiving system that hears those weak DX ("down in the noise") signals that you do not even know are there. Even stacked 11 element beams at 50 feet do not help much. I would rather "pick up" extra gain by lowering my NF. It is cheaper and you do not have to "sweat" the high winds, the ice and the snow. ■



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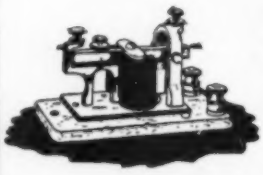

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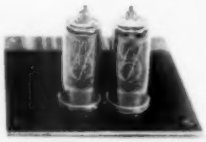

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Ham Q Quiz

Glen E. Zook W5UOJ
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The past few years have shown a remarkable renewal of interest in items and memories of by-gone days. This phenomenon, known as nostalgia, can be carried over into amateur radio. Thus, a list of 100 bits of trivia from the post World War II era has been compiled and listed below. Keep track of just how many you recognize and check the scoring at the end of this article.

Do you remember:

When *73* cost 37 cents?

When there was no *73*?

When Leo had hair?

When Allied was a ham store at 110 N. Western?

30Ds and 16Vs?

The "Old Yankee" and "No kids, no lids . . ."?

When a Hertz was a rental car?

My QTH QSL cards, and those orange ones from Walter Ashe?

The Drake 1A?

When Wayne was an RTTY Editor?

When a base was at Yankee Stadium?

And a collector was from the finance company?

When an 807 was a final and not a drink?

The "Gentleman's agreement" on 20 phone?

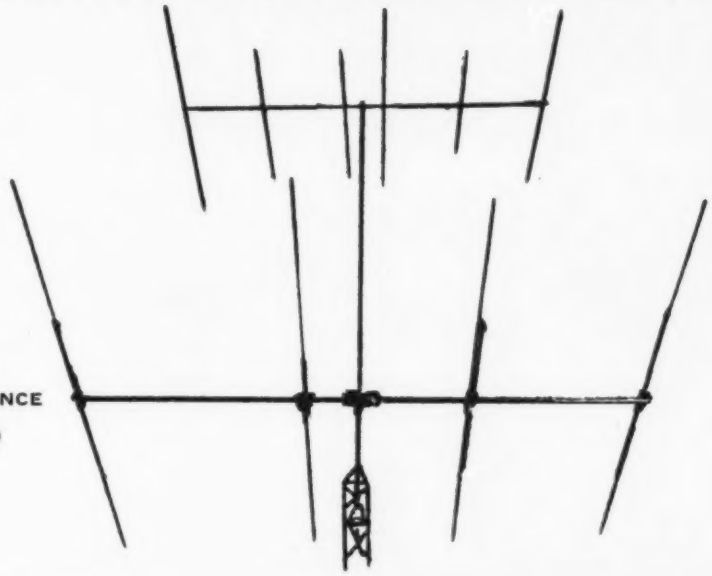
When the DX100 and Viking II were king?

BC 459, 455, and 696?

Hunter Cyclemasters?

Wilson Electronics Corp.

WILSON 204 MONOBANDER PLUS DB33



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- Quality Aluminum
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ICE (not rice) boxes on 2M FM?

When W9IOP won the SS almost every year?

AR3s and AT1s?

Gooney boxes that stared back at you?

The NBFM craze?

Cutting the supressor grid wire on 1625s?

When 11 meters was a ham band?

When we got 15 meters?

When International Crystal built ham kits?

Geloso VFOs, Receivers and Transmitters?

The "Dream Receiver" (the one I had was a nightmare)?

Pacemakers that weren't a medical device?

When Novices could operate 2M phone and Techs not?

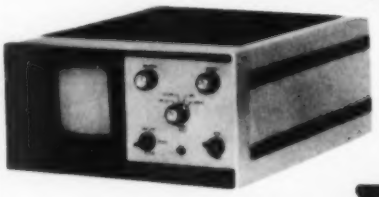
HFS and NC173s?

Swan 120s, 140s, and 175s?

When a Tempo was a music speed?

Globe Chiefs, Scouts, and Kings?

*a CHRISTMAS PRESENT for YOU from VENUS



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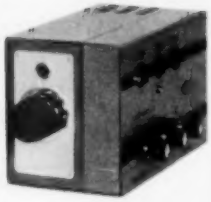

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When a drain was in the middle of the sink?

And a gate was a part of a fence?

Finding out your new call from the Little Print Shop?

When ham licenses were free?

Lincolns and Little Lulu?

When the KWM-1 was the latest thing out?

When there wasn't an S-Line?

When Novices were Crystal controlled?

Link and Dumont?

6AG7s in GG?

20As and tubeless VFOs?

2As, 2Bs, and T-4s?

Invaders and Marauders?

Bandits and pedestals?

Thunderbolts, Challengers, and Harvey Wells?

813s modulated by 811s?

Well, persons, you are now at the mid point of this great listing of amateur radio trivia. How ya doing so far? Well, it's back to the old list. Do you remember:

Swan Mark I and Heath Warriors?

Senecas, DX35s, DX40s and controlled carrier?

When there was only QST?

When there were two?

FM Journal and *rpt*?

Cosmophones and Eldicos on SSB?

Model 12s and 15s not those quiet 28s?

Sunspots, with JAs on 6?

When KWs were built, not bought for $200?

Building your first transmitter?

Your very first QSO?

When portable meant carryable by two persons?

CK722s?

Peanut tubes and acorns too?

Comet, Apollo, Zeus, and Venus?

FM210 plus PA210 from Galaxy?

Globe Champs and 'trotters?

Four-20s and Super Pros?

Gladding, Genave, and Varitronics too?

Prop pitch motors and selsyns with gears?

Morrow and Lakeshore with Sonar to boot?

When a Sentry was a soldier?

When a Swan was a bird?

When Birds only flew, not just read watts?

When Wayne was Editor of that "other" magazine?

6-up?

Carbon microphones and high impedance headphones?

Nuvistors?

When a California Kilowatt was just that?

Your first Field Day?

Mel Shadbolts TV handbook?

Gotham ads didn't have "20 Meters is murder..."?

When the average novice station was a DX40 and SX99?

Ringos and Rangers?

Tuning units from BC375s?

Plug-in coils?

6AG7-807, modulated by Pr. 6L6s?

1296 and APX6s?

SCR522s?

When Tandy only sold leather?

Flying spot scanners and the 931A?

Polycoms on 6 and 2?

Multiphase Products?

Cheyennes, Comanches, with Pawnees and Shawnees?

416Bs and 417As?

1625s at 25 cents each?

Radio Row?

When JAs were "rare"?

Your first DX contact?

Star Roamers and Ocean Hoppers?

Some readers may feel that enough information has not been given in the above quiz. However, if you really recognize and/or remember the trivia then you won't need more information. Be fair and score yourself according to the following:

0-10 "Honey, that's Daddy's 73, your *Sesame Street Magazine* hasn't come yet."

10-20 The "Arkansas Aardvark" is on channel 11.

20-30 Better, but you're still wet behind the ears.

30-40 You can hold your own at the local radio club.

40-50 Venture forth on 20 meters.

50-60 You're a full fledged ham.

60-70 Qualified to B.S. at any convention.

70-80 Ready for 75 meter phone.

80-90 Qualified to write trivia for 73.

90-100 "Hiram Percy who????" ■

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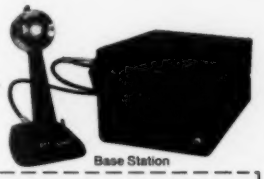
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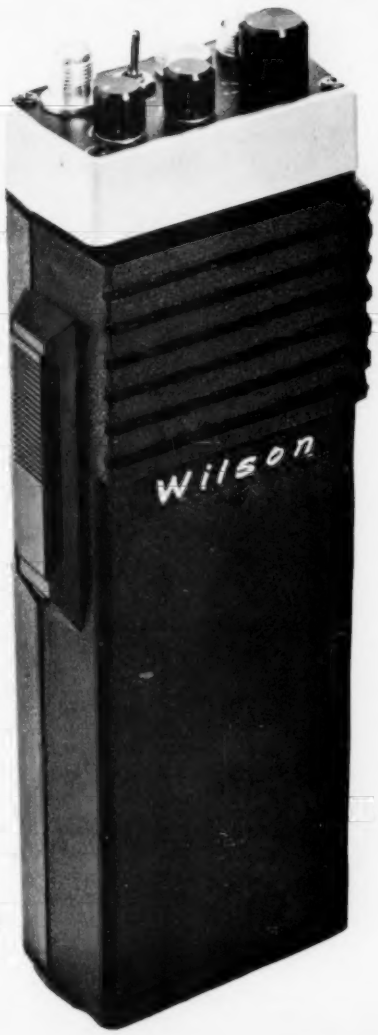

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Saving Ham Radio

You've seen it in every ham radio publication you've picked up lately. Our hobby is in trouble! The editors of the magazines think so. That's why they are editorializing. The equipment manufacturers think so, too. That's why they are slowly going out of the amateur radio business. How many of them would still be with us if it had not been for the two meter boom? The FCC recognizes things are in bad shape, also. Those sweeping licensing structure changes we've heard rumored about so long are now official proposals. The Commission knows it must have numbers behind it in Geneva in 1979...numbers to back up requests for more of the spectrum, or just to hold on to most of what we now claim as ours.

How can we save our hobby as we know it? Obviously, we must get more people into ham radio. As I see it, we have two great obstacles staring us in the face, though. One: that great mass of amateurs out there in radio land who either are ignorant of the facts or regulatory life, are concerned but are too darn lazy to do anything about it, or are too short sighted (the famous.....fewer-hams-equals-less-QRM-for-me syndrome). When these guys are left with nothing but the upper megacycle of ten meters in which to pursue their hobby, they will probably be the first to point their fingers at Newington, Wayne Green, and the other more visible spokespeople for ham radio and let out a multi-decibel "Wha' happened?"

Obstacle number two, I believe, are the new FCC proposals, well intentioned as they may be. I'm afraid they will tend to make more than a few potential amateurs hold off on getting started. Why should I start work-

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ing on that impossible-to-learn code when I can just wait a spell and get on two meters without it? Why don't I just wait for the dust to settle? We are all prone to procrastination. And regulatory wheels grind exceedingly slowly in these bureaucratic times. I am afraid the licensing structure is to be in limbo for some time yet. Whether docket 20282 is designed to save amateur radio or to bail the FCC out of the CB quagmire is beside my point. It can only serve to further becloud the problems we already have.

But before this article gets too depressing, I think I should hasten to add that I think I see some hope. I don't think W2NSD, ARRL or the FCC can bail us out of this one. I think Pogo said it well: "We have met the enemy, and he is us." We are our own enemy if we allow apathy, ignorance or myopia to destroy our hobby. I think it is time the quarter-of-a-million of us who are hams took the bull (if you will pardon the expression) by the horns.

Fact: ours is the most fascinating and enjoyable hobby going. What other hobby offers as many exciting facets as amateur radio, mixes so well with other interests, offers so much opportunity for public service, and gives so many chances for personal accomplishment?

Fact: it just ain't that hard to become a ham. Any average moron can learn the code and enough radio to get a license. There are beaucoups books, courses, cassettes, tapes, study manuals, Q and A manuals, etc., available cheap. Help is there for the asking in most places. It is an honor to get a license, sure, but anyone with the will to learn and the gumption to apply himself to something worthwhile can do it.

Think back. How did you get started? Probably, you lived near a ham, worked with one, or had a brother-in-law who fooled around with the stuff. Most people started that way. Does that mean you have to live next door to a ham or marry his sister to get into the hobby yourself? It is ironic that a hobby that is based on communications depends on word-of-mouth for its growth.

We have a hobby we should be yelling and screaming about, and we sit on it like it's the map to the Lost Dutchman mine. When was the last time you demonstrated the two meter rig for the guys at the office? Or originated a message for some neighbors? Or volunteered to give a talk on ham radio for your civic club?

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That, folks, is PUBLIC RELATIONS!

And ham radio PR is lousy!

Far too few people know what, who or where we are. That image of an eccentric radio nut wiring up his basement and screwing up the neighborhood TV reception is still going strong. And no wonder practically everybody persists in asking if I still have that "CB" in my car.

Next question: *why* is ham radio PR lousy? Because it takes initiative, inspiration and sweat. I certainly think the state of our hobby, and the prospects for its death (at least as we know it), should provide enough initiative. I am about to list ten ideas I hope will give you or your group some measure of inspiration. But there's not much I can do about the sweat part. If you are not willing to work some to see that my son and your kids (and maybe even you) have a hobby in a few years, then maybe ham radio isn't worth saving after all.

Some of the things I'm going to mention are not new or especially imaginative, but maybe you never thought of them before. Some have been, or will be, tried by the Birmingham Amateur Radio Club with varying degrees of success. If you give them a try, look out. You may run into brick walls with some. But you will get far better results than you dreamed with others. I only hope you will take the ball and run with it. It is fourth down and time is running out.

1) Get yourself or representatives of your group on a television or ratio talk show. The stations have to come up with an interesting show every day. Do them a favor and volunteer. It is best to tie in appearances with the start of your club's code-theory class (you club does have such a thing, doesn't it?), Field Day, or the like. Make sure interested parties can get in touch with someone for more info.

2) Land a feature story in a local newspaper. A story about a handicapped ham or a local amateur working through Oscar should be the answer to an editor's prayer on a slow news day. Make sure the editor knows how to get in touch with you and that you have a feature idea or two anytime he needs it.

3) Tie yourself in with local events. If you or your club provides communications for a parade or during a disaster, phone the newspapers, radio and TV, and tell them. They may never know otherwise. We got good newspaper and TV coverage when a Birmingham amateur heard first hand

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about the recent Peruvian earthquake. He called local media and soon found himself entertaining a television news film crew.

Don't be modest! Look where PR got Hugh Hefner.

4) Get a booth at the county or state fair. Sure, it's a headache to keep the booth staffed and handle all that junk traffic. But notice how many people come back to ask questions.

5) Demonstrate your radio for school science classes. The League has a great OSCAR demonstration geared toward schools, too. And the club could probably spare a little beer money to put ham radio books in some school libraries. Be sure to stamp your address or the club's address inside the books.

6) Show off ham radio to the Boy (and Girl) Scouts. Invite troops to club meetings and hamfests, show them ham radio films, attend their get-togethers and answer their questions. Check with local scouting officials. They are in the phone book.

7) Set up a booth at the next Citizen Band jamboree, or what ever they call them. What!?! No, I'm not blowing a final. How many frustrated hams do you imagine there are on 27 MHz? How many would gladly go straight and sin no more if they knew what we are really all about? Some of the best hams I know are reformed CB types.

8) Man a demonstration station in a shopping center. More junk traffic and interminable Muzak, I know, but it sure gets to the people. But, you say, you mostly get women into those places. Don't you agree that one of the biggest weaknesses in ham radio is the failure to attract more of the ladies into our midst?

9) Fire off a news release to the papers at the slightest excuse. Write the release up in newspaper style or like radio spot announcements and send it in. Some will never see print, but none will if they are not sent in. Club activities, interesting occurrences on the air, the implementation of some of the other projects mentioned here...all make good stories.

10) Be a spokesman for ham radio every chance you get. Stand up at your Lions Club and announce the next ham club meeting. Present a program on ham radio to the Jaycees. Explain to the guys at the bar the difference between ham and CB radio.

All this sound like too much trouble? See you in the upper one megahertz of ten meters! ■

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Patching Tales

Over many years of phone patching there have occurred many memorable incidents, some sad, some hilarious. I would like to relate some of both.

One morning about 3:00 a.m. the phone rang, and I was asleep. I answered, and the operator asked, "Are you Jerry?" I said I was. She replied, "I have an emergency call for you." The caller said, "This is John Katsafrakis. I am at Stanford University, and we must get through to Byrd Station, Antarctica. Can you get them for me?" I called Eights Station and raised Byrd via Navy telegraph. I ran a half hour patch, and when it was finished, Dr. Katsafrakis told me that they had released a space craft from Vandenberg Air Force Base, and it was tilted. Someone tried to correct it, and had overcorrected, causing it to tumble. They wanted readings over the Pole, and also predicted that it would fall to earth soon, which it did. I asked him how he found me. He said, someone said "try Jerry in Washington Court House," so I called the operator and got her to find you.

One of the incidents in my phone patching gave me a certain amount of amusement, and yet it was very sad for one of the principals.

A Navy man named Sam was stationed at KC4USM, the "Radio Noise" station about 1¼ miles from Byrd Station in the Antarctic. One night he called me with a plea for a phone patch to Boulder, Colorado. He had received in his mail, which arrived just before the Winter closed all flights to the Ice, a letter from his fiancee that really shook him up.

Frank, a good buddy of his on the summer crew who had left on the first plane out, had stopped in Boulder to see Sam's fiancee and deliver Sam's messages of love. Frank found he liked the young lady himself, and after a quick courtship they became engaged. Frank was on the way to a new duty station in the Canary Islands. The girl, Alice, agreed to get married and go to the Canaries with him. She wrote Sam and told him this.

Sam was desperate. He could not get any letters out for nine months, and could not send tapes. He begged her to wait until he could get a tape to her, but she refused.

She said, "You never

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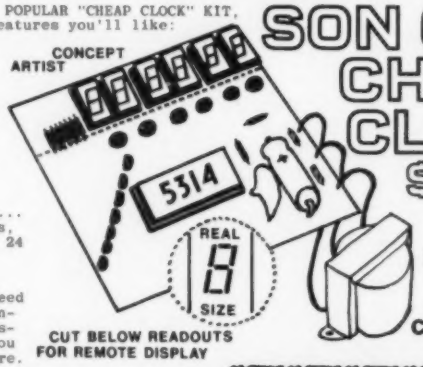

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asked me to marry you, you simply said you were going to the Antarctic, and would see me in about a year. Frank and I get along with each other much better than you and I, and we agree on many things. I am in love with Frank, and to wait for your letter would be useless." He told her he had great plans, and so forth, but she was firm and refused. The patch lasted about an hour, and was one of the best I had ever run. Sam was very appreciative, but downhearted. I was glad that he had not been in the predicament of having to argue his case with a poor signal. For a year afterward, I heard on the air remarks about Sam and his patch. We must have had one of the greatest listening audiences in ham history. He said he was a quiet, scientist type,and not given to expressing himself. I kept thinking back to the John Alden story, with one difference. Frank said to himself, "Speak for yourself Frank."

One of my more weird patches came one night on a patch to nearby Columbus, Ohio. I gave the operator the number, and a man answered. I asked for Jean. He said "Jean is not here any more. She married that guy over at Lancaster when her husband died. Who did you say is calling?" I said, "It is her husband from the Antarctic, South Pole. Station." He replied, "Well, I'll be darned. I thought he was dead." I dropped the line for a minute, and heard the man at South Pole saying, "Jerry, you have the wrong number." I went back to the other man just in time to hear him say, "I'll tell her" and he hung up. I asked the operator to redial it, and found that she had misdialed the prefix. I got another Jean at a different prefix in Columbus, and got the wrong suburb.

Once I had an experience that made me appreciate helpful operators. I had a call to South Carolina, but got a wrong number. I had the operator redial it, but still got no where. I asked the operator what the number was for the person I was calling, after checking with the man at South Pole Station for confirmation. She told me it was an unlisted number. I explained the circumstances, that the man was in Antarctica and wanted to call his wife and had no other means of reaching her. She was adamant. There was an absolute rule about giving out unlisted numbers.

I said, "I think I have the number almost right, perhaps I am off only one digit." She said, "Why

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don't you try running it down one digit at a time?" I said "Do you mean getting ten people out of bed at 3:30 am?" Her reply was, "Oh, it won't be that bad. Why don't you try it, starting at the bottom?" I thought that over and decided she was trying to tell me something, so I called the number again, with 1 as the final digit, and got my number. She came back after the call, and I thanked her. She said, "You are very quick." I felt real good about such a nice operator.

My very longest patch lasted an hour and a half and was a series of relays. A man at Byrd station wanted to talk to his fiancee in Hawaii, as she was to leave there in a week and go to San Francisco to meet him when he came home in a few weeks. She was in a hotel in Maui, and I did not have any chance of getting a direct patch. I ran down a station in Honolulu, KH6HP, in a downtown office building. He could not hear Byrd Station, and Byrd could not hear him, but both stations were copying me fine. However, I was using phased verticals, so when I was talking to Honolulu, Byrd Station could not hear me, and when I was talking to Byrd Station, Honolulu could not hear me, so it was a real slow operation. Byrd to me, to Honolulu, to Maui. KH6HP had no patch, so it was all one way. The reply came from Maui, to Honolulu, to Ohio, to Byrd Station. KH6HP had to take notes and then try to get the messages straight to me, then I had to do the same to Byrd, since nothing could be sent direct. Then the whole thing had to be repeated going west. We got all the information passed, and confirmed. When I finally signed with KC4USB and KH6HP, the phone rang. It was the mother of a man who had been stationed at Byrd Station a couple of years before, and who had a receiver and vertical antenna, and who was listening. She said, "Jerry, how I wish I could have had a recorder to record that patch. It was the finest thing I have ever heard." I had patched her son many times when he was there at Byrd and she had gotten him to put an antenna up for her, and bought a receiver, and she sat up at night listening to Antarctic patches. I appreciated her call. She lives in Decatur, Indiana.

There was another time I had to run a patch for John Katsafrakis in Palo Alto to Byrd Station which I feel was rather interesting.

I got a call on the phone

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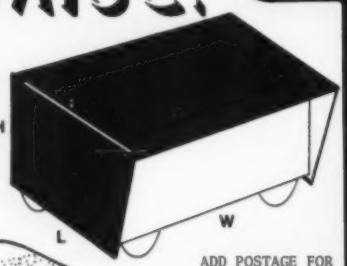

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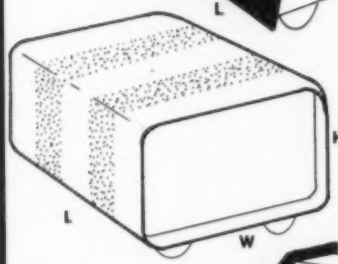

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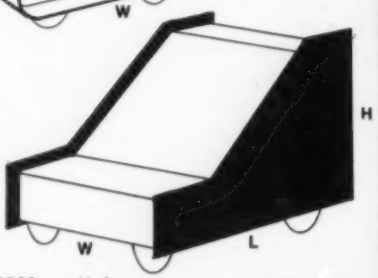

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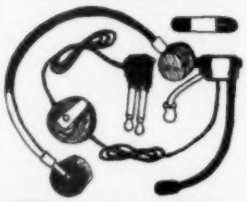

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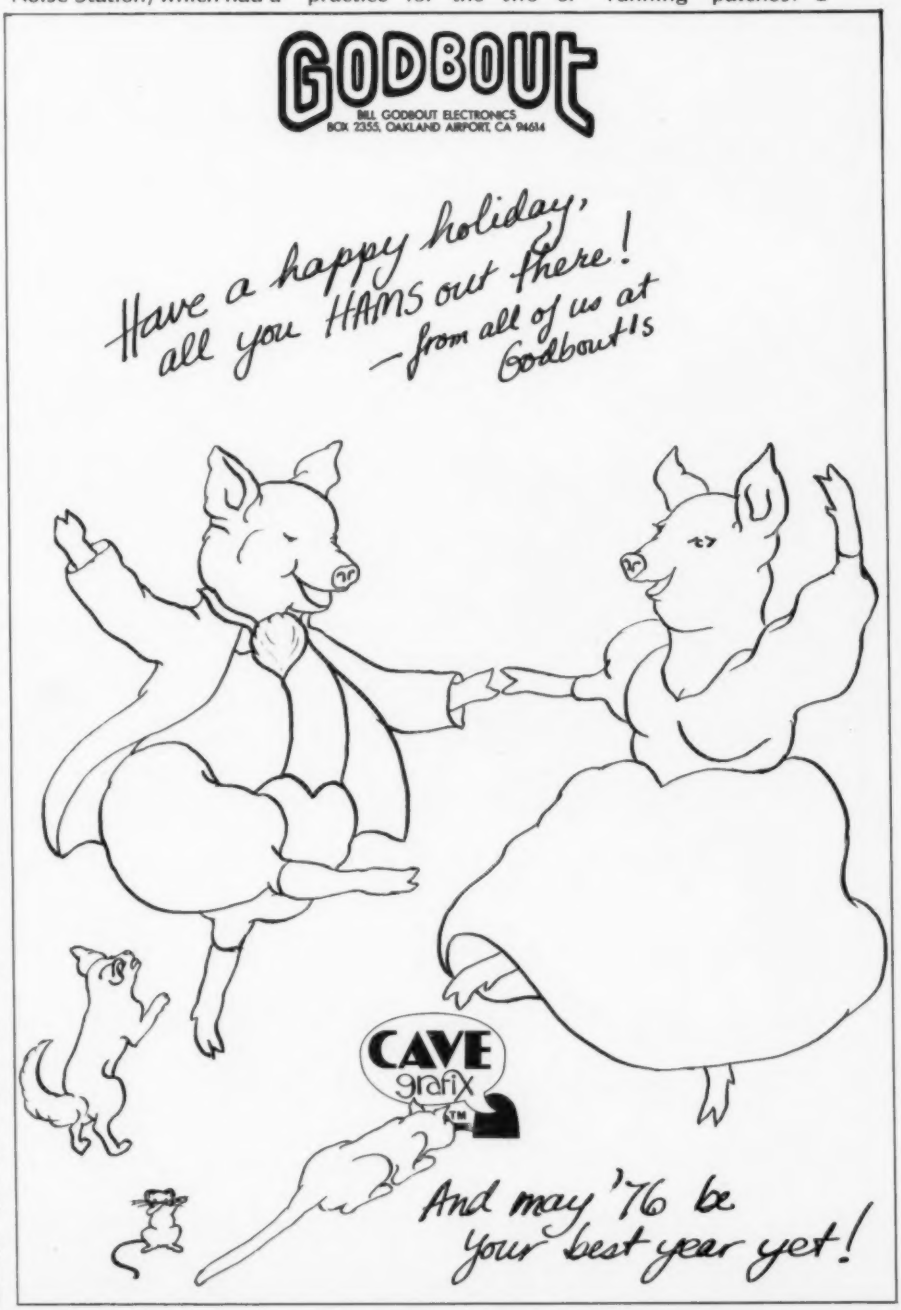
from John, and he had been trying to get a message to Byrd and no one seemed to be able to raise them. He had scheduled a space craft to be launched from Vandenberg Air Force Base in California at midnight EST and had to postpone it because they could not get hold of Byrd. They had then rescheduled it for 1:00 a.m. EST and now it was almost 2:00 a.m. and they absolutely had to cancel if it passed 2:00 a.m. because of another launch being scheduled.

At 1:30 I called McMurdo Sound, KC4USV, and they had been unable to raise any other Antarctic Station all evening. John Katsafrakis had scheduled this launch with plans for no other station than Byrd to take readings. All the time and expense would be down the drain if they didn't get hold of Byrd Station soon.

I remembered that K1TWK in Ipswich, Mass. had a Teletype going into McMurdo which also ran to Byrd Station. I phoned him and got him out of bed, and told him to get a message to Byrd in a hurry. I gave him the name of the man wanted. With the phone line open to California, and the receiver set on 7.290 MHz, our regular traffic frequency, at 1:58 a.m. the man John wanted came through ready to go. They signaled the space craft and the launch took place at 2:00 on the dot.

After the furor died down, I asked the men on the Ice what the problem was. No one had realized that it was MIDWINTER'S NIGHT. This is the greatest celebration in Antarctica. It is the night the sun starts back South, and the mid point of the long Winter night. All stations shut down and the men gathered together for a grand and glorious drinking party. They tried to get through from Byrd Station as soon as they got the Teletype, but could not raise us because of weak signals. Three of them ran the 1.3 miles to KC4USM, Radio Noise Station, which had a better V antenna, and arrived in time for the launch. It was pitch dark and cold and they had to follow a hand line for safety. They knew nothing of the launch because no one had dreamed that Byrd would not be obtainable. It was the usual practice for the two or three men at KC4USM to go into Byrd Station whenever there was any kind of party, to join the 30 or so men at Byrd. It was also common practice to take two or three tubes out of the KWM2A at the stations so no drunk would get on the air and start running "patches."■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Work a Novice

One of my amateur friends told me that he was anxious to increase his code speed and that he was putting in more time on CW in order to obtain his Extra Class license. He mentioned in passing that he would go searching for a QSO, and if he found no takers on the low end of the band, he would migrate up to the Novice segment and work a few of the newcomers just for practice. This remark stuck in my craw. Late one night, when the long "skip" was in effect, I found no CW signals on the low end of forty meters, only Mexican phone stations, so I tuned up to the Novice segment.

After getting accustomed, I found this subband to be a beehive of activity, more often than not. Some of the signals may be a trifle difficult to copy, but by and large they are not vastly different from those to be found in other sections of the same band. It stands to reason that most of these chaps are sending at a slower rate than you will encounter in other CW sections of the band, but again there is no hard and fast rule. Some of these younger operators are quite proficient with the key.

Most of the Novice operators that I have worked were pleased to have made contact with another amateur with a General or higher class license. They impress me as being eager to learn, so you might try to set a good example when you work them. Some operators may regard this as some kind of chore, but really, it isn't. You might look upon it as a bit of enlightened self-interest, for you are helping to mold — hopefully for the better — the OMs that will be the Generals and higher rated licensees of the ham bands of tomorrow.

Sometimes when I find no particular satisfaction in some QSO that I've experienced on the low end of the band, I make it a practice to go up in frequency and work a Novice or two. Perhaps I never did look upon these QSOs from the Novice point of view until a YL operator from the New Orleans area included a short note, along with QSL card, thanking me for taking time out to come up and try for QSOs in the Novice sub-band.

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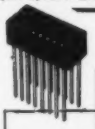

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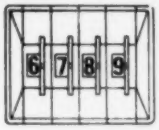

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either coast, or possibly in a hard-to-get state, you may find yourself quite popular. In my own situation, I find lots of WN6 and WN7 hams pleasantly surprised that their relatively low-powered rigs are able to span the continent..... these QSOs are often after midnight, but judging from some of the enthusiastic remarks on their QSL cards, you would think they had succeeded in contacting somebody on Mars!

If you have a little time to spare, and a small measure of patience to go with it, why not tune up to the Novice segment of your favorite band? Chances are you will be pleased by what you hear. You will learn that amateur radio is not going to the dogs after all. And here's your chance to make it just a little bit better. Why not give it a whirl? ■

John A. Carroll K6HKB/1
34 Clark St. Apt. 13
Arlington MA 02174

Capacitors Unmasked

When a circuit refuses to behave the way it's supposed to, one of the places to look for a cause is the capacitor. Disc ceramics and electrolytics are popular because of small size and price, and most of the time they do the job in bypassing and coupling applications. When you measure the impedance at audio and rf frequencies, however, many of them look like anything but a capacitor.

In disc ceramics and the older paper types, a major cause of non-capacitive behavior is dielectric loss. In some materials, a fast-changing electric field outruns the ability of the material to keep up, so energy must be spent to establish the new value of the field. Since energy can only be drawn from a circuit when the current has a component in phase with the voltage, the capacitor acts as if it had a resistor connected across it. Neither the resistance nor the capacitance is necessarily constant with frequency; the resistance probably won't be. Ceramic capacitors rated under 100 volts may have as little as 1/10 of the marked value at 1 MHz even though they measure up at dc; higher voltage discs are more likely to be the other way around. Types vary, so this rule only serves to illustrate how widely values can fluctuate throughout the spectrum. I have only one actual value for a shunt

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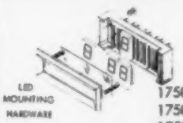

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resistance. A 20 pF disc that I tried to use in a crystal filter looked like a 10 k resistor at 700 kHz, and it lowered the Q from 5000 to 3. So beware of using these things in tuned circuits.

Most people have heard of lead inductance, in which the leads of a capacitor act like an inductor of a few nanohenries, causing the component to series-resonate somewhere in the VHF region. Electrolytics can also develop inductance around surface irregularities in the foil, as well as in the foil itself, causing a resonance in the audio region, after which the impedance climbs rapidly. This is why you'll often find a small bypass capacitor connected across an electrolytic in commercial gear.

Another HF and VHF effect to consider is skin effect in the leads. Rf current doesn't penetrate metal to any great depth, so the leads look much smaller than they really are. Their apparent resistivity rises with frequency, and may put a significant resistance in series with the capacitor. This can be handled the same way as lead inductance: Shorten the leads to an absolute minimum, especially in VHF equipment.

Sometimes a capacitor, especially an electrolytic, may turn up with a true shunt resistance due to leakage. It doesn't have to be internal, either. If a suspected unit looks dirty, try washing the outside of the case.

The point of all this is that a capacitor, or for that matter any component, is never as simple as its symbol or diagram. When a newly designed circuit misbehaves, that fact could be important. ■

Richard Mollentine WA0KKC
19 Edgemere Court
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Why Fight It?

Windmilling is synonymous with large antennas and rotors without braking facilities. If your beam antenna never turns in the wind then FB on to the next article. However, if your beam is a "Horatio Hornblower," then read

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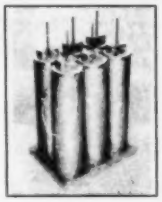

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on. Actually this gets into the psychology of the thing. If you will bury your pride and admit that the darned thing turns every time the gusts blow, and that the built-in gear torque is insufficient to stop it, half your problems are over. "Why fight city hall." Now the only major

problem is that a physically balanced beam won't turn in the most advantageous direction — that is, into the wind where the least wind resistance would be, along and in the same direction as the boom. Since the wind blows equally on the front and rear at the same time, the boom is at a 90 degree angle to the wind. The result is wheezing, pulling, whistling, and a massive strain on the guys, hardware, mast, boom, tower, and the "whole ball of wax." Now if you will admit to yourself that the whole thing is going to move anyway, then why fight it?

Let's take a positive attitude for a change. Have the wind work with and not against us. By installing a small tail fin on either end of the boom, the antenna will automatically always put its thinnest side, or least resistance into the wind; any material, plywood, plastic (invisible), formica, or any other dielectric will do. It won't effect the radiation pattern in the slightest. If plywood is used, better give it several coats of shellac. Run two "U" bolts through it with double nuts and oversized flat washers on all sides. Then when the big blow is over you can reorient and recalibrate the rotor box (which would have to be done anyway).

By now you have probably discovered you can't rotate the array during a wind storm anyway, as the whole thing slips 90 degrees against the wind.

Don't use too big a fin. We only want the big winds to move it, and not the small breezes that the meshed gears could normally contain anyway. With the beam facing into the wind and not against it perhaps you have prevented complete collapse of the entire structure.

The photos show my six meter twelve element "home brew" beam with a commercial eight element two meter antenna above. While not the ideal situation, it will do until I can afford a rotor with a built-in mechanical brake.

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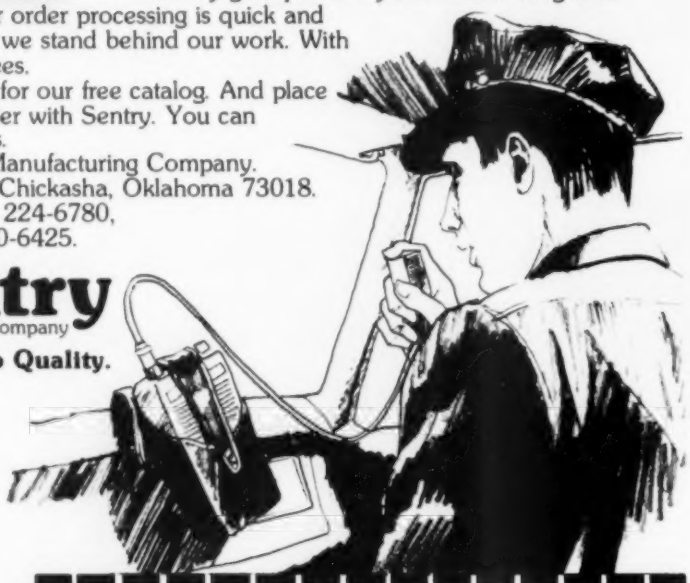

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Ah, a nice day — for May in St. Louis at least. Let's see, things to do . . . Well, I think I'll check the old mail box and see if any of those 85%'ers might have had a change of heart and decided to QSL. The guys in the States that are hardest to work on good old six meters seem to display this propensity of not . . . HELLO? What's this? A notice from the U.S. Post Office or Postal Service (you know, the outfit that cancels those pretty QSL's on BOTH sides). A registered letter awaits me.

(Sigh) . . . we'll just jump in the faithful Jeep and drive down to the Post Office.

Upon identifying myself (all the way back to my ancestors on the Mayflower), a very official looking letter is placed into my determined grasp. Official indeed! U.S. Government markings all over the thing. The last time I saw anything this official, it said something about "Greetings." They wouldn't, I mean they couldn't, but, but I'm too old. Must settle down and open the envelope. After all, I just signed Lord knows what to get it. And get it, I did. After fourteen years as a Technician, a happy, fun-loving (if not slightly pudgy), died-in-the-wool Technician, I received the F.C.C.'s version of "Greetings," a recall.

The day following the receipt of this doomsday message is pretty hazy in my memory but the XYL later told me that for the most part, I was hysterical

and incoherent. At times like these, we non-drinkers are severely handicapped. This will not do. Must pull myself together and face the situation calmly and cooly and think of some flim-flam excuse to stall them off until the next time they swoop down on St. Louis. Yeah, that's it, that will give me an extra three months to get it together. Let's see — dit-da is "A," dah-dit-dit-dit is "B" or "D?" Code records. Gotta have code records not to mention theory books. Gotta find out about those little trans-sa-ma------- goodies that replaced tubes. I constantly had to repel the urge to send in the ticket and slink off somewhere and slash my wrists. Every idea ever conceived to aid in learning and improving the code was considered. Nothing was overlooked. The depths of my panic knew no bounds even to the point of recording several code lessons on cassettes, putting the cassette on a timer and having it try to probe my sub-conscious during my sleep. As weird as this sounds, I really believe it helped. At least, it got me to the point that I had enough nerve to listen to the forty meter Novices. Listen with what? A quick call to my buddy, Bill WA0KBZ who is a true mercenary's mercenary, and I was all fixed up with an Allied AX-190 receiver and a greatly deflated wallet.

Disregarding two of my original ideas of sending in the ticket and the flim-flam excuse, I attacked with all the determination of the chief boiler stoker on the Titanic. I thought it was a good thing they extended the Novice ticket to two years and I was thoroughly convinced that it would take that long to complete a QSO of any length. It wasn't easy but after about two weeks, I could make sense out of that noise. I became fanatical. Working shift work, I was able to copy for three to four, and sometimes five hours a day and go to work to relax.

WA0TXV Bob sicked me on to W1AW. After a few nights of people taking their hate out on the League by getting a hundred or so cycles to the side and CQ'ing and QRM'ing, I deemed that a good CW filter was in order. In my neophyte stages, I didn't realize that the AX-190 and the CW filter only represented the beginning of a never-ending outlay of money.

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came to pass and as this time of year is a slow period in my line of work, the theory books and previously secreted tapes accompanied me to work. It took about eight minutes of dit-dah's and I was up to my bellybutton in disgruntled fellow workers. They had suffered with my "weird" hobby in the form of boring conversation for the last several years but this was the limit. Being the kind of fellow who takes friendly suggestions to heart, I decided to appease this potential lynch mob and suffer silently with an earphone. Now I have nothing against any ethnic group or nationality but I just can't understand what the Japanese had in mind when they contrived those nasty little earplugs. Why didn't they design one that would fit the ear?

The thing was starting to take shape — transistors, formulas, chokes, taps and all the accoutrements of "wireless" started to make a little sense. The code was coming along swimmingly. Visions of a General License with my call kept popping into my code-weary mind and on every occasion that I struggled through the ominous 13 wpm barrier, I sort of giggled inside. The first instincts of mere survival gave way to a more human feeling of REVENGE! Challenge my integrity will they! I had ambitions! I kept thinking of the mean old F.C.C. examiner grovelling in disbelief — not only passing the Tech, but WOWing him with my new-found CW prowess.

The day of decision was finally upon me. I was to be at the examination station at 9:00 a.m. At 5:00 a.m., my eyes popped open and I eagerly got in the proverbial last minute of CW and theory study. At 8:00 a.m. I departed the studios of radio-free K0CBA and plunged forward into the St. Louis sunshine — a raging downpour! The weather should have made me reconsider my idea of a flim-flam excuse. However, with the well wishes of the XYL, the "go get-em" of the local six meter gang and a few well-meaning threats of, "You had better pass because we can't take any more" from the guys at work, I continued my sojourn.

Upon arrival at the Federal Building, I couldn't find a place to park. Another bad omen? Nonsense, I forged ahead as if I had good sense and finally located a parking meter, but it was a "One Hour Only" parking meter. At this point, confronted with the prospects of failure in the amateur fraternity, a tick-

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2.	6.61R	10.	6.73R	18.	6.79R	26.	6.91R	34.	6.52R	42.	7.69T	50.	7.81T
3.	6.04T	11.	6.145T	19.	6.22T	27.	6.34T	35.	6.94T	43.	7.09R	51.	7.21R
4.	6.64R	12.	6.745R	20.	6.82R	28.	6.94R	36.	7.60T	44.	7.72T	52.	7.84T
5.	6.07T	13.	6.16T	21.	6.25T	29.	6.37T	37.	7.00R	45.	7.12R	53.	7.24R
6.	6.67R	14.	6.76R	22.	6.85R	30.	6.97R	38.	7.63T	46.	7.75T	54.	7.87T
7.	6.10T	15.	6.175T	23.	6.28T	31.	6.39T	39.	7.03R	47.	7.15R	55.	7.27R
8.	6.70R	16.	6.775R	24.	6.88R	32.	6.99R	40.	7.66T	48.	7.78T	56.	7.90T

57.	7.30R	61.	7.36R	65.	7.42R	69.	7.48R	73.	7.54R	77.	7.60R	81.	7.66R
58.	7.93T	62.	7.99T	66.	7.45T	70.	7.51T	74.	7.57T	78.	7.63T	82.	7.69T
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et (St. Louis Police Department type), and possibly a humongous tow bill, all I could do was to hum, "Cast your fate to the wind" and fight back my own downpour which was about to trickle from my eyes and go in and scope out the situation. I was a half-hour early and the examination room was still locked so I tried to make conversation with the other hyper-tension stricken people that had gathered under the "NO STANDING IN HALL" sign. My mind briefly contemplated the Governmental wisdom behind the placing of that sign and the fact that there wasn't a chair or waiting room to be seen from horizon to horizon.

A young lad who was observed in the corner with bloodless white knuckles, frantically scanning his license manual, would look toward heaven, mumble to himself and then would appear to "chew" a bit of the book's ragged corner. I got to talking to a fellow who introduced himself as "Dale WN0 something or other" and he mentioned that the code was a snap but he was a bit concerned about the theory. I thought that was a strange thing for him to say. If he had his wits about him, he surely would have been terrified of both elements, just as I was. I quickly ran through the alphabet in my mind. A poor choice of pastimes, and I suddenly realized that I couldn't recognize my own call. I reached in my pocket for a pen and a piece of paper. A note attached to the door, proclaiming that I had been carried away by a roving band of gypsies and would probably be released unharmed in time to take the test in three months, would surely tug at the examiner's heart and he would reschedule me for the next time in town. Surely a fellow couldn't be held accountable under such circumstances. I started to compose the note a bit too late as the door opened and there stood the examiner. He foolishly assumed that because I was closest to the door that I was the most anxious. He asked me what Class I was here for as he relieved me of my F.C.C. provided "610" and "examination appointment." Before I could stutter out an answer, he looked up from my papers and said, "A Tech recall, huh! "Sit over there and fill this out." I took the paper he gave me and wobbled over to the indicated seat. Any composure that had remained with me in the hall, ran down my leg. As the others filed in, he looked at them but always seemed to fire a glance my

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way, or so it seemed. I consoled myself that he wasn't really a bad fellow who had a personal desire to snatch my ticket, and that he probably just learned to look at people like that from when he headed up a concentration camp.

As he passed by me, handing out the paper for the 13 wpm test, I said, "Excuse me, sir, could I have a try at it?" With a patronizing smile, he gave it to me and proceeded with his tasks. After several eternities, the silence which heretofore was only interrupted by nervous laughter, pencils thumping on desks and an occasional drop of perspiration rolling off my proboscis and hitting my paper, was broken by an ear-splitting, "Is everyone ready?" After 6 v's which gave me no trouble, I realized that this was it! I have a real knack for being able to size up a situation. I got the first few words out but then a miss, and another, then a few more words, then the misses again. After the machine sent ar, I started to try to do some fills. No dice. The papers were gone as quickly as they had come. "You may all step into the hall while the papers are checked." After a few minutes of staring at the "No Standing In The Hall" sign, I went into the room to watch. I saw a booklet on his desk which I think was entitled, "The stacking of papers on a desk so no one can see if they passed" and quietly left the room. I amused myself by running the six hundred yard dash to my parking meter, narrowly escaping the clutches of the law which I considered to be a good omen. I walked into the Federal Building as if nothing happened and then it dawned on me that it was raining and I was soaked. So much for that good omen.

Upon being reseated with the others, the "thumbs up — thumbs down" session started. I was in the latter, however, all was not lost. I squirrelled through enough for 5 wpm and so it was on to the theory. Osmosis is a fact and I had inadvertently soaked up enough that I made the theory in pretty fine style.

After the whole thing was just a bitter memory from the earlier part of the day, I became even more obsessed with getting my "Big Ticket." The levity of the situation only now comes to light as I gaze upon my shiny new "Advanced License."

The story doesn't really end here. After all, in September, I'll have my "Year In" and then I'll have a shot at the "Biggest Ticket." ■

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Save Money on Coax

If money is worth anything to you, then the easiest way to save it is to quit using RG8 for anything lower in frequency than 21 MHz, and shorter than 100 feet, regardless of power unless you are running more than the legal limit.

If you are using a dipole, which is about 72 Ohms, and feeding it with RG8, you have an SWR of 1.5:1. If you fed it with RG59, the SWR would be 1:1 at resonance. The loss in RG8 at 1:1.5 would be a little more than .7 dB, and the loss in RG59 would be about 1.6 dB at 21 MHz. The difference would be barely noticeable on the air, even with careful listening. At 7 MHz, the difference would be about .45 dB, and not even discernable.

The power handling ability of RG59 at 20 MHz is 860 watts, and if you use foam coax it is about 1100 watts of steady RF. This is enough for any legal amplifier, and of course for use barefoot there is absolutely no need for RG8, even for a 750 watt PEP transceiver.

The most ridiculous of all, of course, is the ham who insists on running RG8 in a mobile. Many of them seem to feel that with a mobile you need all you can get, but RG8 is harder to handle, and no one could possibly hear the difference between RG8 and 58 or 59, with only 20 feet of line.

If you are running a 50 Ohm antenna, there is some reason to use RG58 instead of RG59, but not much. The SWR will be 1.5:1 but the greater loss in RG58 will almost equal that due to the mismatch, even at 21 MHz.

Oddly enough, there is a good reason why in some cases RG8 has its advantages. The reason is that you can't bend it at sharp angles. Running coax with sharp bends is not good for transmission, and since RG8 won't bend in square corners, it is better at very high frequencies. Wouldn't it be just as easy, and cheaper, to just make sure that your bends are gradual, rather than pay the extra cost?

Many hams buy surplus RG8 and save money, they say. If you do that you had better check the loss in what you buy. All loss tables refer to NEW coax, as you will find out if you measure it. ■

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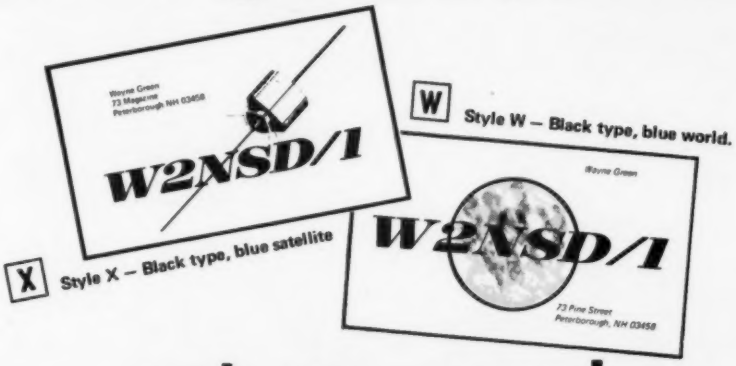

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How to Pass Exams

When I went to school many years ago, I was very lax about studying, but I had great interest in the subjects I took. While in class, I was careful to observe the teacher and try to understand what she was saying. I was the son of a construction engineer, and had traveled so much that I had never been to school in the same state for two consecutive years. Thus I was a sort of loner in the schools because I didn't know any of the kids from previous years. However, I was also a sort of curiosity. Kids used to want to hear about Puerto Rico, Montana, and New York City — three places where I lived at ages 6, 5 and 4.

I used to read a lot and at age 8, I began going to the library every afternoon to borrow a book to read lying in the library yard, and taking it in when the library was ready to close or I had to go home to eat. As a result I rather immersed myself in the book, as if I had really experienced what I read. If anyone asked me about anything I had read, I felt right at home and could answer anything.

I did the same with school books because I had developed a great desire to learn. When the time came for exams, I had no trouble because it was like someone asking me what had happened on a trip.

I took a civil service exam for postal clerk during the depression, and although the exam ran from 8:00 a.m. until 5:00 p.m., I was through at 9:30 a.m. The examiner asked if I was sure I was through. I said I had put down all I knew and there was no use trying to put down things I didn't know.

When the grades came out, I tied with another man for top place. By that time I had another job so they gave the appointment to him. There were 300 who took the exam.

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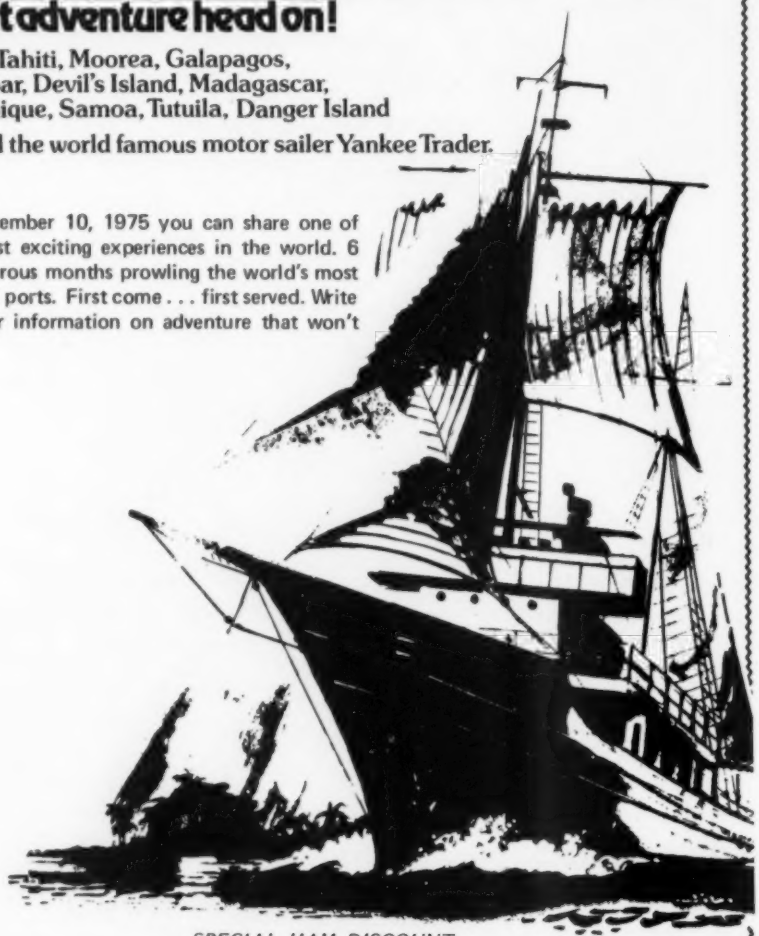

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When I was working at the City of Dayton Engineering Department, an exam came up for transitman, which meant that I could move up a grade. It also was an 8:00 a.m. to 5:00 p.m. exam.

I took the exam and one of the questions was a "Cut and Fill" question. This meant that you had to draw a cross section of a road and make squares to represent cubic feet of dirt. Then you had to compute the cubic feet of dirt in the high spots and place them in the low spots. This was a laborious job and could take a couple of hours. I noticed that the question was #3c. There were 10 questions so that meant that question #3 was 10%. This meant that #3c was only 3⅓%. I thought — "That's not worth the trouble." So I finished the rest of the exam and left at 9:45 a.m. .

When I gave the paper to the examiner, he said, "Are you satisfied? There is plenty of time left." I said I was. "Did you get that Cut and Fill problem?" I replied softly, "Are you kidding — for 3%?" He laughed, and said, "We wondered if anyone would notice that." I was again top grade and got the appointment. When we discussed it next day, the chief of the department said, "It is just as important to know *when* to do something as how to *do* it."

I have since passed difficult radio exams the same way. Most of them now are multiple choices and I never took more than 45 minutes for one. I have been studying psychology for many years, and I combined the two. After several years study I have come up with this method. I am sure that it will help many of my readers, but to be helped, you must accept what I say without blocking its result by not believing in it.

Your mind is divided into two parts — the conscious mind and the subconscious. Everything you know, everything you have ever seen or heard — is in your subconscious. A good hypnotist can bring out any or all of what is in your vast subconscious mind. The question is — how do YOU do it. Very simply, by being your own hypnotist!

It sounds simple, but it is not quite as simple as it sounds. Before it really works, you have to have a way to get at what you want without having to delve through your entire lifetime to find it.

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way that you can find it. The best way to do this is the same way I studied when I went to school. You must *understand* what you are learning. If the teacher or professor goes by anything you don't completely understand, stop him at once, and make him explain it. In the first place it is your right to demand this, but best of all, if you are sincere, you will please the teacher. A good teacher is always pleased when his pupils are interested in what he is teaching. When you understand it, it goes in your mind as a unit, and is much more easily recalled than if you were to memorize a lot of disconnected facts and try to recall them.

Your mind is made up of a lot of nerve cells called neurons. They are all almost connected together. They have little gaps separating them and when a neuron is activated, a little electric charge discharges across the gap. This gap is called a synapse. When the discharge takes place a number of times, the resistance decreases and the gap is jumped more easily. This is "training."

Advertisers use this to train your mind to think of their product. They say that it takes 36 repetitions to fix the path. Did you ever smell something cooking and have a vision come to your mind of a kitchen back in your childhood, or smell a perfume and have it bring back a romantic memory? The same principle applies to the recall of information. When you see a question on your exam paper, you want the answer to come into view.

I was president of a training film company for thirty years, and I used one primary rule of learning. You must accept whatever the teacher or books say without reservation for rapid learning. Pick your authority with care, but once you do that, then never question anything you read, for the present, anyway. This way your mind is very receptive to learning. If you begin to question anything, you skim off the information at your present level of knowledge, and therefore learn nothing. Furthermore, by your negative attitude you slow the learning process. If you accept everything, you will at least know more than you did before, though you may learn a few things which you may later wish to change.

I had to learn in a day or two everything my customer had learned in twenty or thirty years. I did this

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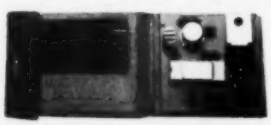

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by accepting everything he said as if it were being poured into my mind with a funnel. It will amaze you once you try it. If you learn under relaxation, it will further intensify the learning process greatly.

I once had a film writer ask me to teach him everything about film editing in one day, as he had a job interview in Washington the next day. We both worked in the Motion Picture Divison of Wright Field. I was chief of the editing branch. I explained about the theory of funnelling knowledge into the mind and relaxation, and he understood. I spent the day telling him everything I knew about editing. He went to Washington, got the job, and in several months became the Producer of all Training Films for the National Labor Organization.

Some people learn sound better than sight, and I am one of them. If I want to remember a date, I say it aloud, and remember how it sounded.

An excellent way for "Audio" people to learn is to read the information into a tape recorder, and then play it back under relaxation. This also works for the "Visual" people, who remember what they *read*.

In fact, reading what you want to learn into a tape recorder and playing it back under relaxation is about the best way for anyone to learn anything.

At college, many students take a tape recorder to classes they are unable to attend either because of illness or because they have another conflicting class at the same time. They put the recorder on their desk, and leave, and pick it up after class. Another student will turn it on or off for them. Thus they have the entire class discussion for study when they review.

Now for learning directly with your subconscious, by-passing the conscious mind entirely. This is very good for subjects which depend on instantaneous decisions, such as taste in decoration or dress. It is also useful for touch typing, and I will give you a spectacular example.

During World War II, in North Africa, the U.S. Army trained African natives to type telegraph code directly from the headphones to the typewriter. Simple, you say? Except for the fact that none of the natives could speak English or even read it. They were taught that dot dash meant A, and so on, until they could copy at a high rate of speed without having the slightest idea what they were hearing or writing.

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As you may have observed, a good telegraph operator can talk to you while he is copying from a telegraph wire at high speed because he is not using his conscious mind at all.

You can learn composition in painting or judging art and the like the same way. To explain with your conscious mind why a composition is good is very difficult to do, and hard to learn. But by looking only at good art your subconscious can learn extremely fast.

My wife and I used to go on automobile trips, and she being very much interested in architecture, would point out houses and tell me what had been changed on the house, and how it should look. These were classic old homes which had been "modernized" by having small paned windows replaced with large glass and having parts removed and added. I had no education in architecture and decided to learn.

How to learn quickly — that was the question. Then I had an idea. I thought of the bank clerk I had once been, and how a teller could pick up a counterfeit bill at a glance from among many good bills. The reason, of course, was that he was accustomed to looking at good bills. I decided to use this principle, but with greatly expanded fields. I got several architectural magazines from the library, and leafed through them. Then I began to look at news stands, and while I was waiting in advertising offices. I often had to call on these offices for work, and they all had magazines with beautiful homes. The following summer, when we went on vacation, my wife mentioned a house we were passing. I quickly glanced and said, "Yes, they have added dormers and changed the entrance." She was surprised, and asked how I knew. I said that I had been studying architecture.

Let's try to bring this into your field. Do you identify cars readily? Or are you familiar with cameras? If you are a connoisseur of high-priced cameras, can't you tell if someone puts a cheap one with them? The reason is that you have unconsciously been mentally photographing what you see and it is retained in your subconscious mind.

Now comes the distinction. When you study day by day, you are studying and reciting with your conscious mind. But your conscious mind can only handle a limited amount of information, so the work is given you in amounts you can handle.

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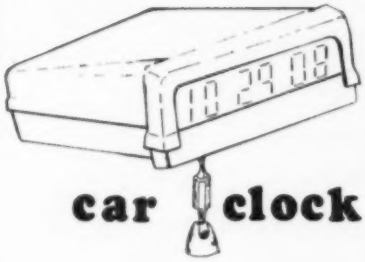

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You've been self-hypnotized many times. You have entered hypnosis spontaneously literally hundreds or even thousands of times, depending on your age. We all slip into a trance at times every day of our lives, though such situations are not labeled hypnosis.

Dr. Griffith Williams, of Rutgers University, has written of these spontaneous states in an article in Experimental Hypnosis (New York: MacMillan, LeCron editor). Daydreaming is nothing but a state of hypnosis, perhaps light, sometimes deep. When we concentrate intently on anything, such as reading a book, watching a motion picture or TV program, or even on our work, we tend to slip into a trance. It is even probable, as Estabrooks has pointed out, that we do so whenever we experience a strong emotion, such as fear or anger.

How Hypnosis Feels

A hypnotized person is never unconscious. He knows what is going on all around him. He can even walk or talk while under hypnosis.

Only a light degree of hypnosis is needed for our program. In this stage there is no specific sensation of being hypnotized. All you feel is a listlessness and great relaxation. After you have followed this program for a week or so you can test yourself by telling your finger to feel tingly. If it does, it means that you are hypnotized. If it does not, either you are skeptical or have not kept at it long enough.

Incidentally, you can use this method to help you when you are studying, by letting you concentrate when there are many things going on around you.

If you like, you can record the words you are going to say, in a low monotonous voice, or you can even read them to yourself aloud or silently. It may take a little longer, but it may be easier for you.

How To Hypnotize Yourself

1. Select a place or room in your home where you can be reasonably sure that you will not be distracted by the telephone or other unnecessary noises or interruptions. It will help to draw the blinds or subdue the lights. Soft music often puts some people more quickly into a state of hypnotic relaxation. You may want to experiment by selecting a type of music that is soothing and

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☐ **6 WPM** This is the practice tape for the Novice and Technician licenses. It is made up of one solid hour of code, sent at the official FCC standard (no other tape we've heard uses these standards, so many people flunk the code when they are suddenly – under pressure – faced with characters sent at 13 wpm and spaced for 5 wpm). This tape is not memorizable, unlike the zany 5 wpm tape, since the code groups are entirely random characters sent in groups of five. Practice this one during lunch, while in the car, anywhere and you'll be more than prepared for the easy FCC exam.

☐ **14 WPM** Code groups again, at a brisk 14 per so you will be at ease when you sit down in front of the steely eyed government inspector and he starts sending you plain language at only 13 per. You need this extra margin to overcome the panic which is universal in the test situations. When you've spent your money and time to take the test you'll thank heavens you had this back breaking tape.

☐ **21 WPM** Code is what gets you when you go for the Extra Class license. It is so embarrassing to panic out just because you didn't prepare yourself with this tape. Though this is only one word faster, the code groups are so difficult that you'll almost fall asleep copying the FCC stuff by comparison. Users report that they can't believe how easy 20 per really is with this fantastic one hour tape. No one who can copy these tapes can possibly fail the FCC test. Remove all fear of the code forever with these tapes.

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conducive to "sleep-like" relaxation.

2. Lie down on a bed or comfortable couch or semi-reclining chair, placing your feet on a hassock or some other firm object serving the same purpose. Loosen all tight clothes.

3. Take three deep breaths. Breathe deeply and slowly.

4. Close your eyes.

5. Say to yourself, as if to another person (your subconscious mind):

"You are going to relax all the muscles of your body ... starting from your head to your feet ... The muscles of your face and neck are relaxing ... The muscles of your shoulders and chest are relaxed ... You're beginning to feel free of all muscle tension ... Your arms feel limp and relaxed ... The muscles of your thighs, legs and feet are relaxed. As you breathe deeply and slowly, your entire body is completely relaxed. You feel calm and relaxed all over."

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After you have practiced the prescribed method of relaxing yourself each day for more than a week, and you are satisfied that you are able to relax completely, you are ready to use a more rapid method of autorelaxation.

Say to yourself. "You are going into relaxation at the count of three. One - two - three."

Rapid relaxation can also be achieved in the waking state. You give yourself the count and quickly experience a relaxed feeling throughout your body. Your mind suddenly becomes relaxed and receptive to suggestions. You suggest to yourself that hereafter whenever you use the work "Relax," the relaxation will occur instantly. If you are walking or sitting, you naturally are going to keep your eyes open. You tell yourself that you are completely aware of your surroundings at all times, and that you are in full control of your mind, except that you are in a state of self-induced relaxation as well as a state of increased receptivity to self-given suggestions. Once you have practiced this rapid method of hypnotically induced relaxation, you are ready now to make good use of your subconscious mind by giving it suggestions. Your subconscious mind will do for you what you want it to do. By repeating and repeating a given suggestion to your subconscious mind, you will accomplish your objective.

Twenty percent of the population are extremely easy to hypnotize. These are the ones who enjoyed the play, *Harvey*, with the big "invisible" rabbit.

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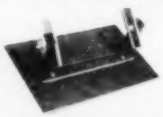

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They could actually see him. They are the people who enjoy eating in restaurants where the menu and signs tell you how wonderful the food is and the fabulous taste of everything you eat. My sister is one of these. She enjoys everything if the signs tell her she will. I am of the 20 percent which are hard to hypnotize. No matter what the menu says, if the food is not up to standard, nothing on the menu can make me enjoy it.

The second 20 percent are relatively easy to hypnotize, but cannot have hallucinations. I believe that these two groups, of 40 percent, are the ones who will benefit most from this folio. They are most likely to be afraid of examinations, and pay too much attention to remarks in class and elsewhere about how hard the exams are.

By all means do not tell anyone you are studying this article. Many of them will ridicule it, either because they don't understand it or because they want to downgrade your ability to make themselves feel good. These negative comments and influences will cancel part of the positive influences I am trying to give you, if you are suggestible, and cause you to fail. You MUST think positive — that you KNOW that you will pass, or this is wasted.

Remember that under hypnosis you could recall everything you had seen or heard all your life? If you were to pass a man on the street and glance at him, a hypnotist could have you recall every detail of his appearance. You could tell what sort of socks and tie he wore, the color of his eyes, and every detail of his dress. The same thing happens when you look at a book, or a newspaper. If you read an item in a newspaper, you are also scanning all the other material on the page. If there is an item about a red-haired man committing a murder, you may find that you have a feeling against red-headed men, and you will never know why.

So, now let's glance at each page of our book which deals with the subject of our examination, deliberately turning the pages slowly and glancing at the whole page. Do not try to read anything on the page, just "microfilm" it with your eyes. This will put the entire subject in close proximity with each part of it, so when you go to recall it, you can quickly scan it for your answer. I use the word scan, but the speed of scanning is faster than any computer.

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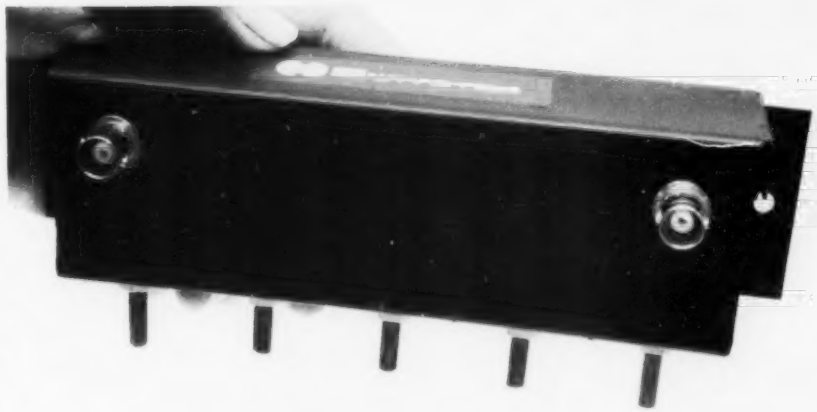

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going to pass the examination. When I go into an examination room, I KNOW I am going to pass. It never even occurs to me that I would fail. I don't always make perfect grades, but I always pass. Any feeling that there is any doubt about it tends to inhibit your recall. If anyone asks if you are worried, just smile and say, "No."

Each night when you go to bed, give yourself the key word, "Relax," and say, "When I wake up I will feel wonderful, and full of energy, and have confidence that I will pass my exam." When you go to take your exam, you will know that you have everything you need to know in your mind, and all you have to do is say, "Relax," and tell your subconscious to give you the answers.

After you have completed giving yourself post-hypnotic suggestion, either in the sleep-like or waking state, you can tell yourself that at the slow count of ten, you will rouse yourself from the self-hypnotic state with a feeling of emotional well-being, inspired by the conviction that you are going to benefit immensely from the application of the particular suggestions you have given yourself.

When you start, take each question, read it carefully, watching for tricky wording. Be sure you know exactly what the question is. Then look at the multiple choices. If you cannot answer a question at once, go on to the next but put a little mark at the left of the question. Don't waste time now. This is one of the big mistakes most people make. They get stuck on something they don't know and don't have enough time at the end to answer the last questions.

Go ahead and answer all the questions you can, and then go back and pick out the ones you could not answer. First, try to eliminate the two impossible answers. That will leave three. Two of them will look like the right answer, probably. Guess on one if you don't know the answer. Do NOT leave any question with NO answer. All examinations are designed to allow for guessing. If you were to guess at all 100 questions, you would likely get a grade of 20%. If you can eliminate the two impossible answers and guess out of the three left, you will get one of three right.

Usually 70% is passing. This means that you can have 30 questions out of a hundred that you can miss. If you guess wisely, you can probably guess ten of the thirty right. This would give you 80%.

All of this assumes that

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HAM DIES OF BURST BLADDER!

Word has just reached the 73 offices of the recent departure for that great DXpedition in the sky of a very avid 73 reader. Upon investigation it was ascertained that said ex-ham had, shortly before his demise, received delivery of a bundle of back issues of 73. Apparently these so captured his attention that other functions were totally forgotten.

BE WARNED. Back issues of 73 should be taken in moderation. Even though they arrive in bundles of twenty, no more than two should be read at any one sitting (of course that depends to some extent upon where exactly you are sitting).

Back issues are available in three different assortments – vintage, mid-years and recent. These are packed by the mentally handicapped (73 is an equal opportunity employer), so no specific issues can be requested . . . you take what you get . . . the only guarantee is that all will be different and some will be musty, particularly the VINTAGE BEAUTIES.

It is advised that you warn your mailman (or UPS man) that these are coming . . . 73 refuses to be held responsible for any more mailman hernia complaints.

The supply of these FANTASTIC GEMS is very limited so run do not walk to your checkbook and flip the $6.50 per bundle to us right now. You'll have more sleepless nights reading these than you've had since your honeymoon.

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you make a serious effort to study the subject thoroughly. It would take first class hypnosis for you to glance through a strange book and pass an exam, but with the right training, you could probably do it.

For Radio License Exams

Now for the code part of the exam. The same rules apply here. You must go in with the conviction that you will pass. You will have five minutes to copy. Do not copy anything for at least a minute, perhaps two. Get the feel of what they are sending. Just get used to the sound and the speed. Remember, you only need one minute of solid copy. Pick a pause and start in. Copy the best you can for about a minute and a half. Then stop and look back over your copy. You may find you have made an "e" look like an "i." Correct it. Just try to fix any uncertain letters that may make the examiner wonder what you meant. Tell your subconscious to time you.

Before you go to take the exam, try timing yourself by relaxing and see how close you come. I can come to within a few seconds this way. Practice a little. Starting to copy when the code starts coming is very unsettling. You are surprised by the echo in the room, or the charcter of the sending, and at the same time trying to put down what you are reading.

Use the hypnosis instructions when you are learning the code. A well known hypnotist found that it was possible to distort time to the extent that you could practice listening on the violin in ten seconds what should take ten minutes to study. This would mean that you could, under hypnosis, copy five words a second instead of five words a minute, and this would mean reading 300 words per minute instead of five. Think about that for a while. ■

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County Hunting

Remember how you counted the days waiting for your ticket to finally arrive? Recall the first time you fired up your rig... your first QSO...your first real DX...those elusive last states and countries you needed for the WAS and DXCC you wanted so badly? When you think about it, if you're like most of us, you constantly set goals for yourself. Maybe it's making the DX Honor Roll or the BPL Medallion or coming in first in the Sweepstakes or just being the best operator you can. Whatever the goal, whether you achieve it or not, it eventually loses its importance. Normally you just set a new goal. But, sometimes there just doesn't seem to be anything worth getting excited about; hamming isn't any fun anymore. Well, if you're looking for a real challenge, something that will provide lots of competition, require good operating skills and endurance, yet provide numerous rewards and lots of fun, you've found it! It's called county hunting.

County hunting is kind of like working all states 61 or 62 times over, or if you prefer, like making the DX Honor Roll ten times. All you have to do is work a station in each and every one of the 3076 counties evenly distributed throughout the United States. Sound interesting? It's quite a challenge. Only about 120 hams have managed to do it. But don't let that discourage you because that exclusive group includes a ZL1 and a G4. And if they could do it with the propagation we've been having, anybody can do it.

Of course, achieving a goal isn't much fun if you don't have something tangible to show for your efforts. Fortunately, there are two rather attractive awards being offered by well known organizations to those who manage the feat. Both award programs begin with an initial requirement of several hundred counties, for which you receive large certificates you'll be proud to display in your shack. As you add more counties to your total, you receive special seals to be applied to your certificates. Finally, when you finish them all, you receive beautiful wall plaques.

While the two award programs differ in some important details, both permit you to claim every contact you ever made, or ever will make regardless of your call or QTH at the time. The only requirement is, of course, some proof that the contact was made. But more about the nitty-gritty later. If you're like most hams, you've got a shoebox full of old QSL cards and old log books buried in a closet somewhere. If you do, you're off to a good start. But whether you want to use those old contacts or start from scratch, you're

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going to need a reliable means of determining in just what county each station you work resides. Of course, if he tells you or has it printed on his QSL card, there's no problem. This isn't the usual situation though. That's why sooner or later you'll want to get your hands on the "Directory of Post Offices", available from the Government Printing Office under the stock number 3900-00242 for $4.25. This marvelous publication lists every Post Office in the U.S. as well as the county in which it is located.

The Rewards

Once you've got yourself squared away, you'll want to decide which of the two available awards you want to go after. There is, of course, nothing to prevent you from going after both of them simultaneously — as long as you keep the different requirements for each in mind. The better known of the two is the United States of America Counties Award (USA-CA) sponsored by *CQ Magazine*. This certificate is printed in four colors on white parchment-like stock measuring 14 inches wide by 22½ inches high. The design features full-color illustrations of all 50 state flags. You can get it by submitting proof of having had two-way contacts with amateur stations in 500 counties. If you qualify and so desire, you can have your certificate endorsed for all one band, all one mode, and/or all mobile contacts. There is no minimum signal report required. You must, however, have QSL cards in your possession for each county claimed. But you don't have to submit them with your application. Certification 'by two General or higher class hams is sufficient. If by chance you contacted a mobile station that just happened to be parked on a county line, you may claim all the counties in which a piece of the mobile resided. It's sort of like getting two or more for the price of one, but the mobile operator must indicate clearly on the QSL which counties may be claimed.

To apply for this award, you must use a special record book available for $1.00 from the sponsor. Complete rules and procedures for the awards are contained in this record book. After the initial 500 counties have been worked, you can submit additional 500 county lists for the higher class seals. These higher class applications can be made using the record books, but a self-prepared list is acceptable.

The other award is the United States County

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You also get your own name and address on the card (unless you happen to be another Wayne Green, which happens).

These cards are ganged up into large batches and run off the 73 presses in between other work, so you don't get real fast delivery, but you do end up with a fantastic QSL at a ridiculously low price (and there are a lot of fans for that sort of service these days). Somewhere in between producing 73 and BYTE, the staff manages to get QSLs set up and printed. It's a living.

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Hunter's Award (USCHA) sponsored by the Certificate Hunter's Club. This certificate is printed in black on an off-white parchment-like stock measuring 22½ inches wide by 17½" high. The design features an outline map of the U.S. with each county defined and labeled. It is intended that as the county hunter moves from class to class in his quest for the magic 3076, he will color in each new group of counties in a different color. The end effect is a mosaic-like color map of the U.S. You can get it by submitting proof of having had two-way contacts with amateur stations in 300 counties. However, U.S. hams must include at least one county from each of the 50 states. In other words, you've got to work all states before you can get started on this one. DX stations, though, get a break. They need only include counties from 30 states. Any contact may be claimed, but at least a 3x3 report each way is required. You don't need QSL cards, but your log must contain all the required data, and two General or higher class hams must certify it's all there. If by chance you should work a mobile station that just happens to be parked on a county line, you must choose which of the counties you want to claim. If you need all the counties involved, you must establish separate contacts for each of them. Sure it's crazy, but that's the rule.

To apply for this award, you must use a special record form set available at 3/$1.00 from Cliff Evans K6BX. Complete rules and procedures are included in the form. After the initial 300 counties have been worked, you can submit additional 300 county groups for higher class seals, but you must use the special form set for each application.

Once you've decided which of the two awards you want, or decide to go after both of them, you're ready to go. You'll very quickly discover, however, why only 120 or so hams managed it. For one thing, there are quite a few counties in this country that contain no active hams. Even when there are a few active hams in a county, it may still be out of your reach because those hams operate on bands or use modes you don't. But, if you're fairly active, take advantage of state QSO parties and similar activities, check into state and regional traffic nets, and participate in the Field Day contest, you stand a very good chance of nailing down a couple thousand counties in two or three years. After that, they'll come very, very slowly. Under normal circumstances, it should take you around ten years to finish

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up. Why? Just think what the odds must be against your randomly tuning around one day and finding a mobile calling CQ from the one county in Montana or Wyoming or wherever you need.

The Nets — Or How To Cut It Down To Just Four or Five Years!

Obviously there has to be a better way — and that way is the county hunters' net. Actually there are several nets operating in the CW and SSB segments of 20, 40 and 80. The best known and most popular of the nets is the 20 meter Independent County Hunters' Net (ICHN) operating daily at 14.337 MHz. It normally starts up between 14:00 and 15:00 UTC and continues in operation until the band folds. During the summer months a 40 meter ICHN operates at 7.237 MHz. This net starts up around 01:00 UTC and continues in operation until the last county hunter pulls the switch. Both of these nets are truly independent, having no affiliation with any organization and following no formal operating procedures. Though both will accept emergency traffic and render what assistance they can, they exist primarily to get county hunters together with mobile stations.

Another net that plays an important role in county hunting is the CHC-FHC Service Net that meets daily on 3.943 MHz. It usually starts up around 8:00 pm local time and runs past midnight. Depending on the season of the year and propagation conditions, the net is restricted to an area of only a few hundred miles diameter, or may operate coast-to-coast. This net, as the name implies, is a function of the Certificate Hunter's Club. Although it will accept emergency and time-controlled traffic, its prime function is to aid amateurs in their quest for the thousands and thousands of certificates and awards available to the ham community. CHC membership is not required; everyone is welcome to check in. However, since only a small portion of the available awards are county oriented, you hear a lot of non-county hunting activity. Nevertheless, at one time or another, just about everyone of the 3076 counties have run on the CHC-FHC net.

It will take you a while to get used to the rather haphazard operations of these nets. Generally, the process begins with a county hunter picking up net control and getting a couple of others to act as relay stations. After getting things going, the net control will put out a "QRZ mobiles" call. Those mobiles on frequency wanting to give out contacts from their coun-

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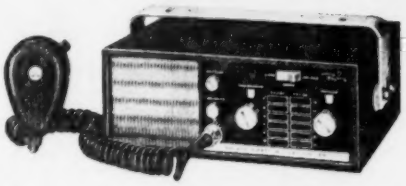

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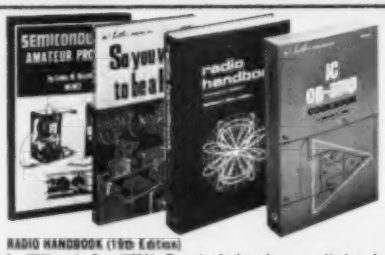
ties then identify themselves and standby. Normally the mobiles are run in the order they are acknowledged by net control, but sometimes the order is adjusted to allow for differing in-county times.

The run itself begins when the net control announces the mobile's callsign and county, has it repeated by the relay stations, and gives the mobile a starting time in UTC. The mobile then puts out a "QRZ such-and-such county, such-and-such state". That's when all hell breaks loose! Unlike the more sophisticated nets, the county hunters' nets have no calling order — it's every ham for himself, just like a DX pile up. I wonder how many hams have stumbled across these pile ups only to go away mumbling to themselves when they discovered the fuss was over a W6 somewhere in California. Adding to the fun is the usual 20-over splatter and an assortment of carriers as well as a group of lids whose total ham activity seems to be tuning up and saying "hello test" on net frequencies. No one knows why, but it is a fact that more of these mental midgets prefer to do their things on the county hunters' nets than on any other. Even with the QRM, the mobile operators do an exceptionally fine job of making contacts. When propagation makes contacts difficult, other stations on the net will help you by relaying the mobile's call, county, state and any other needed information. But, you've got to get your signal reports across without help from anyone. If you can't exchange the reports by yourself, you've got no contact. However, since signal strength can vary from minute to minute, you'll get a second chance at the end of the run if time permits.

QSL Cards — How To Get Them

Getting confirmations is a problem that plagues all aspects of ham radio. Of course, depending on which award you want, you may not need confirmations. But, if you do want them, you're going to have to go get them. You can't just sit back and wait for them to magically appear in your mailbox.

One method that works fairly well with fixed stations is to include with your own QSL a self-addressed, stamped envelope (SASE). Of course, you're still depending on the other station having QSL cards, and being willing to take the time to look up your contact in his logbook. A better method, and the only one to use



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with mobile stations, is to prepare a QSL *from the other station to yourself*. Since your purpose is to get confirmations, not pretty multi-color cards to decorate your shack, you can use a simple 3x5 index card. All you have to do is list all the required data: the other station's call-sign, date and time of QSO, frequency and mode, signal report (the one he gave you), the county(s) and state(s) he was in, and clearly indicate where he is to sign if he agrees with your data. If you prefer, you can use commercially printed reply cards available from WA2AMM, K7LTV, K9EMV and others. Put your name, address and return postage on the other side and you're in business.

The Bureaus

Considering that you must pay letter postage to the other station and postcard postage back to yourself, it's going to cost quite a bit. You can cut the cost down by waiting until you've worked a station numerous times and then putting all the data on a single card. The most economical way to do it, though, is to use one of the two county hunters' QSL bureaus. The best known of these is the Mobile QSL Bureau operated by Dave Manescu W6CCM. This is the bureau the regulars refer to in such phrases as "via the bureau", and "via Charlie Charlie Mike". The bureau will forward your reply cards to the appropriate stations and then return the signed cards to you for just 6 cents each, or 20 for $1.00. Another benefit you derive from using the bureau is the certainty that it has on file the latest QTH of the stations you've worked. Many mobilers provide the bureau with QTH information about portable and extended mobile operations to which you would otherwise have no access. Since it is expected that you will want to send the mobiler your own QSL after the first contact, the bureau will forward these "initial contact" cards free of charge when they accompany your reply cards. With over 500 active county hunter members, the bureau can get you a confirmation for better than 95% of your contacts. Generally speaking, if the bureau can't get you a confirmation, forget it! You can get more information about its operation by sending an SASE to P.O. Box 146, Lakeside CA 92040.

Bob Schmarder WA2AEA operates the other county hunters' QSL bureau, the QSL Clearing House. Its operation is very similar to the

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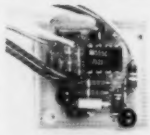

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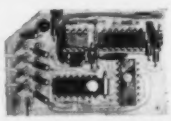

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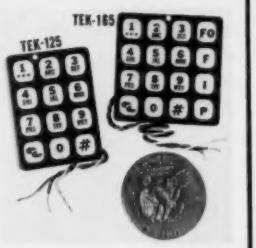

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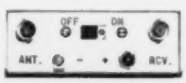

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W6CCM bureau, but it offers some additional services. Whereas the W6CCM bureau will accept cards only for contacts made on the 20 and 40 meter ICHN and the 75 meter CHC-FHC nets, the Clearing House will also accept off-net cards, though at a higher price. However, since it has fewer members involved in county hunting, turnaround time is a little longer. For information about this bureau, send an SASE to 4 Pinewood Circle, Corning NY 14830.

MARAC

Although originally founded to provide a meeting place for active mobile operators, the Mobile Amateur Radio Awards Club has evolved into *the* county hunters' organization. Among its activities is the publication of a monthly newsletter which has become the bible of county hunting. You'll find in each edition lists of counties needed by members to finish particular states, planned mobile trip itineraries, notices about county hunter get togethers throughout the country and other information of interest.

Another MARAC activity is the sponsorship of an awards program built around mobile operation, but available to the fixed-station operator as well. The most popular of these awards is the MARAC Last County Award. This award is available to any station, fixed or mobile, that provides another station with its last county in a state. Seals are available for additional last county contacts with other stations. A special plaque is awarded to the station providing the 3076th county to another station. If you qualify, you can apply for these awards yourself. However, as a matter of practice, many stations will apply for the award in your name when you give them their last county in your state. Other awards are available for working a mobile station in each of the 50 states, for working each of the 50 states mobile-to-mobile, for working YLs in various numbers of counties, and for giving out contacts from various numbers of counties and states.

If you decide you want to get into county hunting, membership in MARAC is a wise investment. You can get complete information about MARAC membership, its awards program, suggested operating procedures for use on the nets, sample reply cards and other county hunting information by sending a self addressed large business size (#10) envelope with first class postage for 3 ounces to Bertha Eggert WA4BMC, P.O. Box 6811, Southboro Station, West Palm Beach FL 33405.

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CW?

Everything discussed so far relates primarily to phone operation. But if you prefer CW to phone, there's another organization that will interest you: the CW County Hunters' Net (CHN). The CHN operates a net on 3.594 MHz every Monday at 24:00 Z, on 7.055 MHz every Wednesday at 23:00 Z and Sunday at 14:30 Z, and on 14.070 MHz every Saturday at 14:00 and at 20:00 Z. Don't be too surprised if you can't find any activity at these precise times and frequencies. Just look around a little for the "QRZ CHN" call.

While your chances of finding a mobile station calling CQ in the phone bands are pretty good, the same can't be said for the CW bands. Fortunately, many of the CW county hunters are also mobilers and run frequent trips for the net. Since these trips are not necessarily run during scheduled net sessions, you'll want to subscribe to the monthly CHN newsletter. In addition to general county hunting information, the newsletter gives advance notice and itineraries for those special mobile trips. You can get a one-year subscription, and membership in the CHN, by sending $2.00 to Jim Hoffman K1ZFQ, 42 Gresham Street, Milford CT 06462.

The CHN also sponsors a county hunters' award program of interest to both CW and phone operators. The United States of America Counties Award by Call Areas is essentially a step-by-step all counties program. You can get an attractive certificate each time you complete working all the counties in a particular call area. KH6 and KL7 are considered separate call areas for this award. When you've got all twelve awards, you'll get a trophy for your efforts. Other awards include working a mobile station in each county of a particular state, working the same mobile in each county of a particular state, and for giving out as a mobile operator contacts from every county of a particular state. You can get more information about the CHN awards program by sending an SASE to George Levensalor W1DPJ, 399 Buck Street, Bangor ME 04401.

If you want QSLs for your CHN contacts, you can take advantage of the CHN QSL Bureau operated by K1ZFQ. The use of self-prepared reply cards is standard operating procedure on the CW nets too. In exchange for some of your self-addressed stamped envelopes, the bureau will handle all of your initial contact and reply cards for contacts made on the CHN, whether regularly

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Other Programs

In addition to the awards already mentioned, there are literally thousands of other awards available that you will qualify for in the course of hunting counties. These range from the so-so CHC program to some very high quality awards sponsored by local, state and regional radio clubs and civic organizations. For example, there are awards for working all the counties of a specific state, for working so many stations in a given county, for working counties of the same name in different states, for working so many stations in a given city or in a given radio club, and so on. Although about half of the awards listed are CHC sponsored, there are many worthwhile awards sponsored by independent organizations listed in the CHC's *Directory of Certificates and Awards*, available from K6BX.

If you ask most active county hunters what they most enjoy about it, they will probably tell you it's the many friendships they've made. Eyeball QSOs are commonplace as mobile operators roam the countryside. County hunters living within reasonable distances often visit each other. The annual MARAC National Convention held in July provides an opportunity for hundreds of county hunters to get together for both socializing and problem solving. Frequent "mini" conventions sponsored by local county hunters throughout the country provide a meeting place for those not able to make it to the national convention.

Throughout this discussion I've used the masculine pronoun "he". Don't get the idea, however, that you have to be a male to participate in county hunting. The fact is that you don't even have to be a ham, much less a male ham, to take an active part in county hunting. Both the USA-CA and the US-CHA programs are open to SWLs on a heard basis. Many other awards are also available to the SWL. As far as YLs are concerned, there is probably a higher percentage of YL participation in county hunting than in most other ham activities. Many of the YL county hunters are also active mobilers.

In short, there is something in county hunting for just about everyone. Why not check into the nets and see what it's all about? I think you'll find it both interesting and challenging, and if you're like us, you'll soon be hooked too. ■

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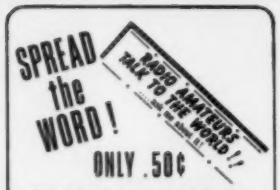

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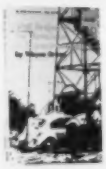

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by
Richard L. Price WB5MJT
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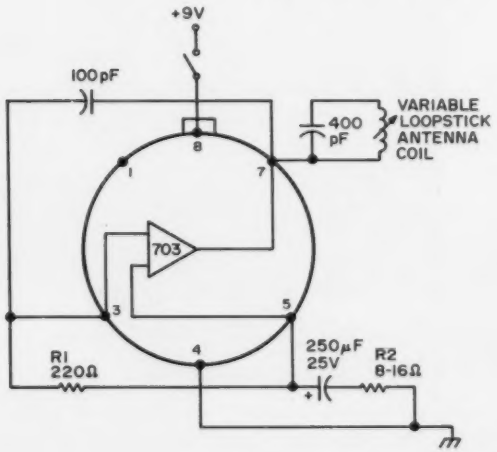
Recently I was approached at the FM station where I work by one of the announcers who wanted to know what the funny voices and pulses he heard on his all-band radio were. After I tried to explain in simple terms that it was CW and SSB and why they sounded that way, he gave a blank look and asked if I could fix his radio so he could understand what they were saying.

Later, after going over a multitude of circuits, all requiring transformers, trimmers, pots, and a good deal more effort than I thought the project deserved, I was reminded of a similar situation involving a 12 year old cousin who wanted an AM wireless mike. The wireless mike used a National LM703 rf i-f amplifier in a simple oscillator circuit. A quick check to a reactance chart and replacement of the original speaker/mike with R2 gave the circuit shown here: a 455 kHz BFO using only a handful of common junk box parts, requiring only about 30 minutes to build.

At the time of this writing the LM703 only cost 99¢ for single units at Radio Shack for tested ICs. The 703 is good to at least 150 MHz and is rated at 200 mW dissipation. With a few minor changes in the tank and elsewhere, this basic circuit can be used as a QRP phone or CW rig, signal source, BFO at frequencies other than 455 kHz, or in other circuits as a LO, etc.

Maybe this will prompt some of us to do some experimenting with the 703 for preamps and such but just as important, I hope the circuit will help some beginners and Novices get their feet wet in building and using home brew gear in their station. ■



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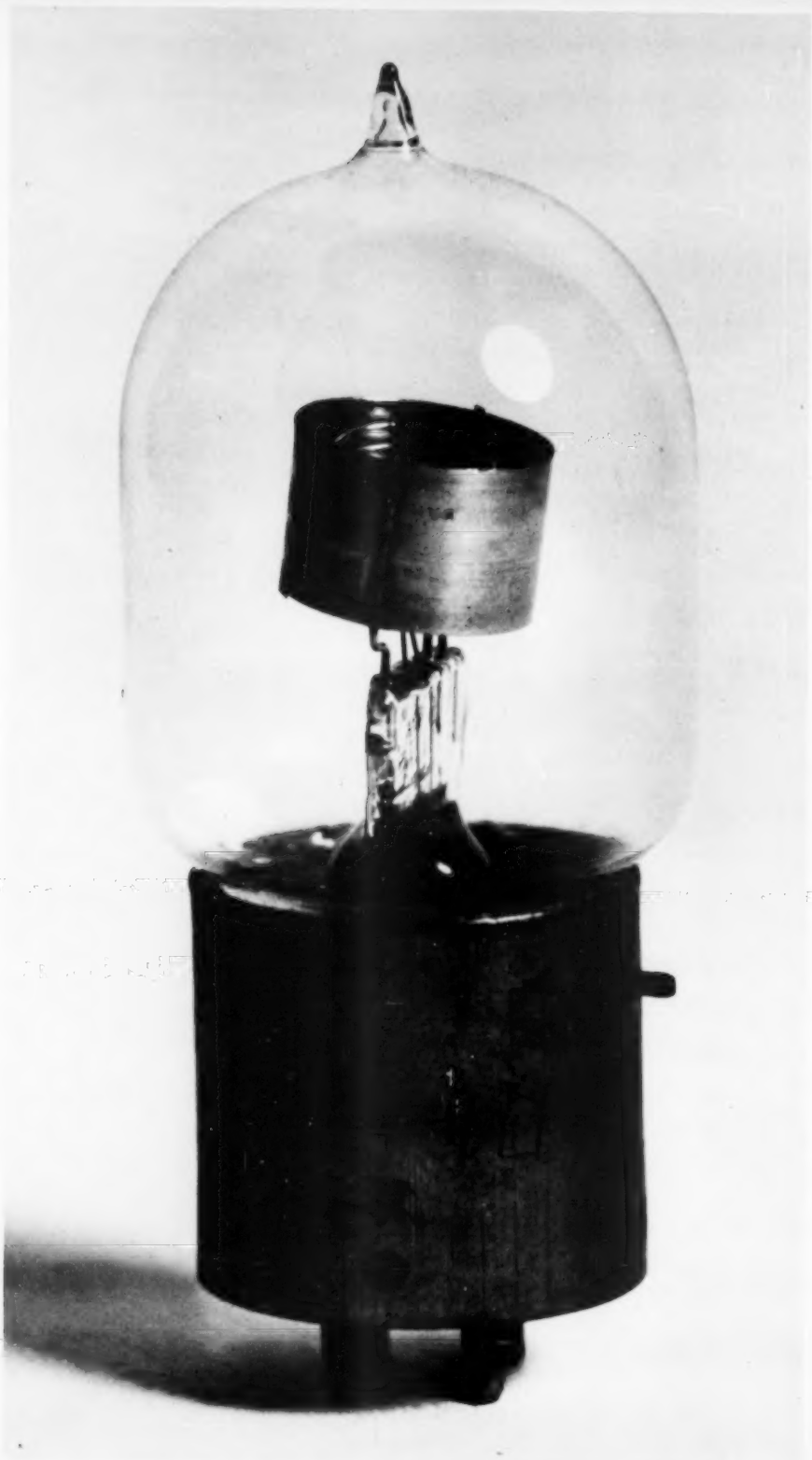

Empty State

We call transistors and such solid state now, because they are dense. Small, but solid. They have an almost mythical twin, an empty state device, which is larger in outline – much larger – but so unsubstantial that the working elements if turned edge to, would disappear. By actual rather than apparent volume, or weight, these are negligible, and the container is 99% empty. This *doppelganger* of the solid state device is called a valve, or tube.

Two generations ago, there was practically no solid state device in use and the valve was called upon, singly or in rows, to do any electronic job that had to be done. When solid state became popular, we tried to apply what we knew about valves to them. We were slapped on the wrist by the authorities, who, to a man, pontificated that there was no relationship whatever.

This was obviously an exaggeration, but this fact was apparent only to the uneducated. For the valve certainly had an emitter, a base, and a collector, though they were called by different names.

Solid state elements, such as the transistor, emit electrons – or holes – at ambient temperatures. This requires no heating power at all, but when the ambient temperature falls to zero or below, the transistor stops working. The valve keeps right on working, because the temperature of the emitter is raised to 1,000 degrees Centigrade, or higher. This can be done by a flashlight battery if the emitter is in the form of a filament about one thousandth of an inch thick. Larger elements require more power, of course.

In general, it has escaped notice that the empty state devices can be wired in all the ways that solid state devices can. For instance, for highest gain, there is the grounded emitter. Grounded base gives stability and negative feedback, just as with solid state, and is particularly popular for linear amplifiers. Even grounded collector is used, as with a large device which has a high collector capacity, and so is grounded to permit very high frequency operation. This is encountered only with large water-cooled valves. Valves are also connected in the Darlington mode, but this is more troublesome than with transistors, because of the heater supply. Oh, I almost forgot – grounded collector modes are used with small valves after all, when a low impedance output is desired, as with feeding a long audio transmission line. In this application the valve circuits are called "cathode followers." Isn't this a quaint name?

Input is connected to the base, and output from the cathode. The drop is from the emitter (cathode) through the load resistance to ground. It is called a "cathode follower" because the cathode signal voltage goes up and down along in phase with the grid voltage, and a very little bit less. But while the grid current is extremely low, the cathode current and the signal available is substantial, and the distortion negligible, because of the 100% voltage inverse feedback.

There was a time when hi-fi addicts hated output transformers, claiming that they always changed the signals into something else, not even recognizable. They wanted "OTL," or "Output-Transformer-Less cir-

In general, it has escaped notice that the empty state devices can be wired in all the ways that solid state devices can . . .

cuits," and a number of workers zeroed in on this one.

Think of the cathode follower as a boy in a box. A black box, of course. You feed in power at one end, and get regulated power out the other end. Or you get a substantial signal out, even though the output impedance is low. What you don't know is that the output variations would be wild, except that the boy has a big rheostat in there. When you screw up the output, he unscrews it with his big rheostat, and you don't see the change you would otherwise see. But this holds only over a certain range. When the kid runs out of rheostat range, the output is suddenly as bad as it would have been all along without the kid and his rheostat.

Several amplifiers were built using cathode follower principles. One used four — count them, four UV 211 50 Watt bottles, with a transmitting power supply. It figured an Ampere at 1200 volts, or some such. The amplifier actually did work, and sounded good, but the designer admitted that the thing was highly impractical.

The valve can be operated in any of the classes that transistors or FETs can: A, B, C, D or in between. But while a transistor normally operates class B and has to be forward biased for A operation, the valve needs a negative bias for class A.

All together, a valve base circuit is essentially high impedance, like an FET and most unlike a transistor. The output is lower, usually very much lower, like the FET again, and most unlike the transistor, whose collector impedance is higher than its base impedance. Circuitwise, this is the most important difference between solid state and empty state devices.

Think of the cathode follower as a boy in a box . . .

The empty state device was invented by Lee deForest in 1906. He called it an audion. He wasn't sure how it worked, and neither was anyone else in those days. The electron had been discovered and weighed, but had no more impact on industry than the theories of A. Einstein. Valves were called thermionic up until the middle thirties, just as if ions had anything to do with their operation. Then, suddenly, they were electron tubes.

The AT&T Co. was building a transcontinental line in those days. By using the loading coils of Michael Pupin, and wires as big as your thumb, they had gotten a line that would talk from New York as far as Denver, but no further. A repeater, or two-way amplifier was needed. The directions were separated by means of bridge circuits (called hybrids) and there was the Brown amplifier, which was a head receiver coupled to a carbon transmitter, essentially. This actually worked, but with high distortion and low gain.

Mr. deForest's bulb looked like the answer. AT&T bought rights from the inventor, and Western's tube department — newly organized — improved it. They mounted the bulb on a four-prong, bayonet base to go in a shell-type socket. They retained deForest's double wing pattern, with a grid and a plate on each side of a V filament. The V was supported at the top, and sometimes there were two Vs, or an M filament, called a W.

The filament was made of platinum, coated with oxides of barium and strontium, of which the former was more active. Recently, this kind of coating has been called an N-type semiconductor, since it emits electrons. Tungsten and thoriated filaments also emit, but there is nothing semi about their conduction, so the concept doesn't help much. The coating is, however, up to a hundred times more emissive than the others. It was invented by Wehnelt, in Germany, about 1902 or 1903, before the audion itself.

Now AT&T could extend their transcontinental line to the coast.

The repeater tubes looked very much like the WW I "VT-2" and were made and used up until the middle thirties. They were rated at 50,000 hours life.

The device in the photo is a Moorhead Soft Detector, meaning that it contained a trace of gas. It dates back before 1920, and in those days it was still thought that a sensitive detector required the ionizing feature. The theory was that you critically adjusted collector voltage, emitter temperature and base leak so that the device was barely beginning to ionize. Then a signal would come along and push it over the edge, and the collector, or "space" current would increase sharply. The VT-1, the receiving valve in WW I, was also soft, for the same reason, but was used at low voltages as an audio amplifier as well.

The Moorheads included two other types: an amplifier and an oscillator, or transmitting tube. The last was called "The Golden Tube," which could be due to the gettering employed. It is my belief that these tubes, together with the UV 200, 201 and 202, had a smear of phosphorous pentoxide brushed on the plate. Over a long period of time, this would be evaporated and a molecular layer of phosphorus, or its compound, would be uniformly distributed over the glass. This gave it a beautiful golden color. I have a UV 202 and a UV 201 which both show this. The phosphorus was used as a "getter" to improve the vacuum and keep it high, and I must say I never saw or heard of a soft 202. After the UV 201-A appeared, early in the twenties, only metallic getters

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were used. Perhaps the phosphorus was too hazardous.

The Moorhead illustrated has some very odd features. For instance, the grid is a close-wound helix, free-standing, with the top end unsupported. This might make the tube outstandingly microphonic, or perhaps the length keeps the resonant frequency too low to bother. I'll have to try it and see. The emitter is tungsten (Wolfram) and is a simple hairpin loop, deForest fashion. The collector is supported at each side, and in this tube is tilted.

The tilt puzzles me. The other two Moorhead types never have a crooked collector – they are ramrod straight. Mine, and all the others I have seen pictured, have this rakish tilt to them, like a JG's hat. Maybe Moorhead was careless with these, but I don't believe it.

Back in those "spark" days, detector sensitivity was *the* classic problem. After all the critical adjustments of voltages, what else could you do? You could mount a permanent bar magnet near the tube. If you found the right tilt, and the right spot, and the right polarity, and the right distance, you could up your sensitivity to a marked extent. For trial, of course, you took the magnet in hand, but to use it you had to provide a bracket. It is hard to remember so far back, but it seemed that the magnet was always aimed downward a little.

High school physics students used to use test tubes with rubber stoppers, or even milk bottles (glass), evacuate them with the school pump, and burn them for a few hours. Those sealed with sealing wax didn't last long . . .

So it is possible – and I don't insist on this explanation – that the collector was tilted so that the magnet could be clamped level, which would eliminate the necessary tilt adjustment.

When broadcasting started, in 1921 or so, there were all kinds of tubes employed, including military types. Soon, however, there was a civilian market. The UV 200 and 201 gave way to the first super tube, the UV 201-A. This cost $9.00 when that was a day's pay. But it took only a quarter of the emitter power that the UV 201 did, but more and better, you could hear a marked difference in the signals.

In 1926, the ac tube was introduced. This activated the emitter surface with a separate heater, which could be heated by household ac with no trace of hum, thereby eliminating storage batteries with their damaging acid. The "no trace" was a purely theoretical concept – they did hum, slightly or a great deal, depending on circuit design.

Then the multi-base and high output devices proliferated, and the empty space age came into full flower.

Before WW II, the velocity-modulated valves appeared. One was the magnetron, used in radar and in cooking, and the other was the klystron. Both were essentially VHF devices.

Radar demonstrated that valve detectors were not so hot at UHF, and the old cat-whisker crystal detectors were studied. With zone-melting and doping of germanium and silicon, it was possible to build solid state devices on a production basis with uniform characteristics for the first time, and the solid state age had its beginnings. The first radar detectors used point contact devices, but even these had to be doped. By "forming" currents, a tiny fraction of the wire contact was diffused into the semiconductor, making a tiny local PN junction. The old-fashioned natural crystals already had their doping – of a random nature, which is why you had to hunt for "sensitive" spots.

The next development was the point-contact transistor, but this chapter is well-known. In England there was a vogue of making your own transistor from the wafer in a diode. The stubs of heater wires from a broken tube were used, with a stem as a mount, the whole thing formed, and presto! One had his own homemade transistor.

The experimenters used to make their own tubes, too. A number of workers used to burn out one filament of a double-filament headlight bulb, thus securing a plate or collector element. The filament was used in normal fashion as an emitter. This made a diode. A coating of tinfoil on the bulb made a base element with a *mu* of one tenth or one hundredth or some such. But considering the high impedance of the input, it was still possible to get some gain out of the device. High school physics students used to use test tubes with rubber stoppers, or even milk bottles (glass), evacuate them with the school pump, and burn them for a few hours. Those sealed with sealing wax didn't last long, but some workers went far beyond this. One ham actually made split-plate magnetrons of hard glass just before WW II. He said it was easy, but no one else duplicated his valves, so far as I know.

The original magnetron had one cylindrical plate. The next had a split plate, split into two troughs along their axis. This was in the early forties. The British invented the cavity magnetron, like an internal gear, with each cavity of such size as to be resonant at the operating frequency. Next, they were kept in phase by two wires that ran to alternate lips. This was a transmission line, and it kept the cavities oscillating in phase for more output power.

Magnetrons were capable of large outputs, but they were noisy. Small klystrons with tunable cavities were used as local oscillators for VHF superhets. Then came the tropo-scatter systems, with their 110 dB transmission paths – if you could call that

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XC226R	5/$1	
XC226G	4/$1	
XC226Y	4/$1	
XC226O	4/$1	

.185" dia.

XC526R	5/$1	
XC526G	4/$1	
XC526Y	4/$1	
XC526O	4/$1	

.190" dia.

XC111R	6/$1	
XC111G	4/$1	
XC111Y	4/$1	
XC111O	4/$1	

.200" dia.

XC22R	5/$1	
XC22G	4/$1	
XC22Y	4/$1	
XC22O	4/$1	

.200" dia.

XC556R	5/$1	
XC556G	4/$1	
XC556Y	4/$1	
XC556O	4/$1	

.085" dia.

MV5B		
.085" dia. Micro		
Red only		
	6/$1	

DISPLAY LEDS

FND70 DL707 MAN2 MAN3 MAN7 DL747 DL338

TYPE	POLARITY	HT	
MAN 1	COMMON ANODE	.270	$1.95
MAN 2	5 x 7 DOT MATRIX	.300	3.95
MAN 3	COMMON CATHODE	.125	.39
MAN 4	COMMON CATHODE	.187	1.95
MAN 7	COMMON ANODE	.300	1.50
MAN 7G	COMMON ANODE-GREEN	.300	2.50
MAN 7Y	COMMON ANODE-YELLOW	.300	2.50
MAN 72	COMMON ANODE	.300	1.50

TYPE	POLARITY	HT	
MAN 74	COMMON CATHODE	.300	$1.50
DL707	COMMON ANODE	.300	$1.50
DL747	COMMON ANODE*	.600	1.95
DL750	COMMON CATHODE	.600	2.49
DL338	COMMON CATHODE	.110	1.95
FND70	COMMON CATHODE	.280	.99
FND503	COMMON CATHODE	.300	1.75
FND507	COMMON ANODE	.300	1.75

IC SOLDERTAIL — LOW PROFILE (TIN) SOCKETS

	1-24	25-49	50-100
8 pin	$.17	.16	.15
14 pin	.20	.19	.18
16 pin	.22	.21	.20
18 pin	.29	.28	.27
22 pin	.37	.36	.35

	1-24	25-49	50-100
24 pin	$.38	.37	.36
28 pin	.40	.44	.40
36 pin	.60	.59	.58
40 pin	.63	.62	.61

SOLDERTAIL STANDARD (TIN)

14 pin	$.27	.25	.24
16 pin	.30	.27	.25
18 pin	.35	.32	.30
24 pin	.49	.45	.42

28 pin	$ .99	.90	.81
36 pin	1.30	1.20	1.15
40 pin	1.58	1.45	1.30

SOLDERTAIL STANDARD (GOLD)

8 pin	$.30	.27	.24
14 pin	.35	.32	.29
16 pin	.38	.35	.32

24 pin	$ .70	.63	.57
28 pin	1.10	1.00	.90
36 pin	1.75	1.40	1.35
40 pin	1.75	1.59	1.45

WIRE WRAP SOCKETS (GOLD) LEVEL #3

10 pin	$.45	.41	.37
14 pin	.39	.38	.37
16 pin	.43	.42	.41
18 pin	.75	.68	.62

24 pin	$1.05	.95	.85
28 pin	1.40	1.35	1.10
36 pin	1.59	1.45	1.30
40 pin	1.75	1.55	1.40

50 PCS. RESISTOR ASSORTMENTS $1.75 PER ASST.

ASST. 1	5 oz.	10 OHM	12 OHM	15 OHM	18 OHM	22 OHM	1/4 WATT 5% – 50 PCS.
		27 OHM	33 OHM	39 OHM	47 OHM	56 OHM	
ASST. 2	5 oz.	68 OHM	82 OHM	100 OHM	120 OHM	150 OHM	1/4 WATT 5% – 50 PCS.
		180 OHM	220 OHM	270 OHM	330 OHM	390 OHM	
ASST. 3	5 oz.	470 OHM	560 OHM	680 OHM	820 OHM	1K	1/4 WATT 5% – 50 PCS.
		1.2K	1.5K	1.8K	2.2K	2.7K	
ASST. 4	5 oz.	3.3K	3.9K	4.7K	5.6K	6.8K	1/4 WATT 5% – 50 PCS.
		8.2K	10K	12K	15K	18K	
ASST. 5	5 oz.	22K	27K	33K	39K	47K	1/4 WATT 5% – 50 PCS.
		56K	68K	82K	100K	120K	
ASST. 6	5 oz.	150K	180K	220K	270K	330K	1/4 WATT 5% – 50 PCS.
		390K	470K	560K	680K	820K	
ASST. 7	5 oz.	1M	1.2M	1.5M	1.8M	2.2M	1/4 WATT 5% – 50 PCS.
		2.7M	3.3M	3.9M	4.7M	5.6M	

ALL OTHER RESISTORS FROM 2.2 OHMS - 5.6M AVAILABLE IN MULTIPLES OF 5 oz.
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14 PCS. POTENTIOMETER ASSORTMENTS

ASST. A 7 oz. 10 OHM 20 OHM 50 OHM 100 OHM 200 OHM 250 OHM 500 OHM
ASST. B 7 oz. 1K, 2K, 2.5K, 10K, 20K, 25K, 50K
ASST. C 7 oz. 50K, 100K, 200K, 250K, 500K, 1M, 2M

$9.95 Per Asst.

Each assortment contains 14 pcs of 10 turn pots. All pots are available in single unit quantities $.99 ea.

PRIME INTEGRATED CIRCUIT ASSORTMENTS	ASST. A	7 oz.	SN7400 SN7410	7493 7438	7402 7440	7403 7472	7406 7473	55 PCS. ASST.
	ASST. B	7 oz.	SN7447 SN74145	7490 74175	7451 74180	74100 74181	74121 74193	50 PCS ASST.
	ASST. C	7 oz.	CD4001 CD4016	4002 4017	4011 4019	4012 4023	4013 4030	C/MOS 57 PC ASST.
	ASST. D	7 oz.	LM301 LM311	304N 5057	3071 5077	307K 7017	309K 7416	LINEAR 510 PC ASST.

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74LS00	.39	74LS55	.39	74LS151	1.50
74LS02	.39	74LS73	.65	74LS153	1.89
74LS03	.39	74LS74	.65	74LS157	1.55
74LS04	.45	74LS75	.79	74LS162	2.25
74LS05	.45	74LS76	.85	74LS163	2.25
74LS08	.39	74LS83	2.19	74LS164	2.25
74LS10	.39	74LS86	.65	74LS181	3.69
74LS13	.79	74LS90	1.25	74LS190	2.85
74LS14	2.19	74LS92	1.25	74LS191	2.85
74LS20	.39	74LS93	1.25	74LS192	2.85
74LS26	.49	74LS95	2.19	74LS193	2.85
74LS27	.45	74LS96	1.89	74LS194	2.25
74LS28	.49	74LS107	.85	74LS195	2.25
74LS30	.39	74LS112	.65	74LS257	1.89
74LS32	.45	74LS132	1.95	74LS260	.55
74LS40	.49	74LS136	.65	74LS279	.79
74LS51	.39	74LS138	1.89	74LS670	5.95

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C & K ROCKER SWITCH
$0.69 Dim: 1" x 1" x ¾"

They are rated at 125 Vac @ 5A. They are excellent in applications such as Microcomputer Panel Switches

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THUMBWHEEL SWITCHES

SPOT SWITCH
HIGH QUALITY P.C. TYPE **69 ea.**
PUSH BUTTON SWITCHES
FOR INSTRUMENT APPLICATIONS
½" x ½" x 3¼" .69¢ each

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IN751A	5.1	400m	4 1.00
IN752	5.6	400m	4 1.00
IN753	6.2	400m	4 1.00
IN754	6.8	400m	4 1.00
IN9658	15	400m	4 1.00
IN5232	5.6	500m	.79
IN5234	6.7	500m	.79
IN5235	6.8	500m	.79
IN5236	7.5	500m	.79
IN456	75	400m	6 1.00
IN458	150	7m	6 1.00
IN485A	180	10m	5 1.00
IN4001	50 PIV	1 AMP	.09
IN4002	100 PIV	1 AMP	.10

TYPE	VOLTS	W	PRICE
IN4003	200 PIV	1 AMP	.10
IN4004	400 PIV	1 AMP	.10
IN3600	50	200m	6 1.00
IN4148	75	10m	15 1.00
IN4154	35	10m	12 1.00
IN4734	5.6	1w	.79
IN4735	6.2	1w	.79
IN4736	6.8	1w	.79
IN4738	8.2	1w	.79
IN4742	12	1w	.79
IN4744	15	1w	.79
IN1183	50 PIV	35 AMP	1.60
IN1184	100 PIV	35 AMP	1.70
IN1186	200 PIV	35 AMP	1.80
IN1188	400 PIV	35 AMP	1.90

TRANSISTORS

MPS A05	5 $1.00	PN3567	3 $1.00	PN4249	4 $1.00
MPS A06	5 $1.00	PN3568	4 $1.00	PN4250	4 $1.00
2N2219A	3 $1.00	PN3569	4 $1.00	2N4400	4 $1.00
2N2221	4 $1.00	PN3569	4 $1.00	2N4401	4 $1.00
2N2222A	4 $1.00	2N3704	5 $1.00	2N4402	4 $1.00
2N2369	5 $1.00	2N3705	5 $1.00	2N4403	4 $1.00
2N2369A	4 $1.00	2N3706	5 $1.00	2N4409	5 $1.00
2N2415	5 $1.00	2N3707	5 $1.00	2N5086	4 $1.00
2N2484	4 $1.00	2N3711	5 $1.00	2N5087	4 $1.00
2N2906A	4 $1.00	2N3724	$ .65	2N5088	4 $1.00
2N2907A	4 $1.00	2N3725	$1.00	2N5089	4 $1.00
2N2925	5 $1.00	2N3903	5 $1.00	2N5129	5 $1.00
2N3053	2 $1.00	2N3904	4 $1.00	2N5138	5 $1.00
2N3055	$ .89	2N3905	4 $1.00	2N5139	5 $1.00
MJE3055	$ .89	2N3906	4 $1.00	2N5209	5 $1.00
2N3392	5 $1.00	2N4013	3 $1.00	2N5951	5 $1.00
2N3398	5 $1.00	2N4014	3 $1.00	C106B1SCR	2 $1.00

CAPACITOR CORNER

50 VOLT CERAMIC DISC CAPACITORS

	1-9	10-49	50-100
10pf	05	04	03
22 pf	05	04	03
47 pf	05	04	03
100 pf	05	04	03
270 pf	05	04	03
470 pf	05	04	035

	1-9	10-49	50-100
001	05	04	03
.0047	05	04	035
.01	05	04	035
.022	06	05	04
.047	06	05	04
1	12	09	08

100 VOLT MYLAR FILM CAPACITORS

001mf	12	10	07	022mf	13	11	08
.0027	12	10	07	.047mf	21	17	13
.0047mf	12	10	07	.1mf	27	23	17
.01mf	12	10	07	.22mf	33	27	22

20% DIPPED TANTALUMS (SOLID) CAPACITORS

1	15V	28	23	17	3.5	35V	38	26	21
1.5	75V	28	23	17	2.2	25V	31	27	22
2.2	15V	28	23	17	3.3	25V	31	27	22
3.3	15V	28	23	17	4.7	25V	32	28	23
4.7	75V	28	23	17	6.8	25V	35	31	24
6.8	15V	28	23	17	10	25V	38	35	29
10	15V	28	23	17	15	25V	63	50	40

MINIATURE ALUMINUM ELECTROLYTIC CAPACITORS

	Axial Lead			Radial Lead		
1	50	15	12	10	07	25	12	10
1	50	15	14	11	37	50	15	10	11
1.5	50	15	13	10	1	15	15	13	10
4.7	25	15	14	12	1	50	15	13	11
10	25	15	13	10	1	50	15	13	11
10	50	15	13	12	2.2	16	15	13	10
22	25	17	15	12	2.2	25	15	13	10
47	25	17	15	12	3.3	25	15	13	10
47	50	20	18	15	4.7	16	15	13	10
47	25	19	17	15	10	16	15	13	10
47	50	25	21	19	10	25	15	13	10
100	25	24	20	18	10	50	16	14	12
100	50	25	30	28	47	50	24	21	19
220	25	32	28	25	100	16	19	15	13
220	50	35	31	28	100	25	24	20	18
470	25	33	29	27	100	50	35	30	26
1000	16	35	30	25	220	16	23	17	15
2200	16	70	62	55	470	25	31	28	25

much loss a "path"! The land terminals used klystrons so big they didn't look like tubes at all; they were about seven or eight feet long, heavy, and filled with machinery for tuning. In tubes of that size, cathode emission is a problem, especially peak emission. You can't get it with just heat, direct or indirect. So an auxiliary cathode – filament – was set up and biased several hundred volts negative with respect to the main cathode. The auxiliary bombarded the main cathode and guaranteed enough peak emission. I know very little about it, really – a good look and ten minutes of talk was all I got. But I do know something else: This system was invented by A. McL. Nicolson, who also invented the indirectly-heated cathode. All commercial tubes are licensed under his patents. The bombardment-emission patent number is different, though: # 1,210,678. I don't know when it was filed – as early as 1915 or as late as 1919, or any time in between. The tropo system and the Texas towers date back to 1950 or so, some 30 years later.

During WW II Sylvania developed a tube which could be fired out of a cannon and survive . . .

There were various developments in these empty devices such as the lighthouse, or disc-seal tubes. They were so-called because of a kind of tiered construction that resembled a lighthouse. They were used at UHF and in radar systems. The highest development of the lighthouse tube is in the 416-B and -C triodes used in the TD-2 microwave system. They don't look much like lighthouse tubes, but that is what they are, essentially.

These old devices may be moribund, but they're taking a long time to die . . .

There are also the tiny nuvistor tubes of RCA, designed to compete with transistors. They can't, really, but they do have a high gain and good output for their size, and come in many types. They are all metal with a ceramic base which is also the mount. They are tiny enough to hide in your ear, should you want to.

For a long time, the tiniest tubes were the battery-operated hearing-aid types. They got smaller and smaller, and finally wound up as a flattened tetrode (glass) with wire leads instead of a base, tiny, and with a half volt filament. The idea was to burn three tubes in series from a dry cell. The filament drain was something like 20-30 mA.

During WW II Sylvania developed a tube which could be fired out of a cannon and survive. It came in two types – an oscillator tube, and a thyratron. Both were hearing-aid sized, but they used indirectly-heated cathodes. The oscillator was a Doppler radar oscillator/detector with a range of only a few yards. At its nearest approach to a target, just when it began to pull away from it, it would fire the thyratron (gas tube) which controlled a lot of current and could directly fire the fuse that exploded the bursting charge in the shell. This was one of the hottest developments in WW II and was known as the proximity fuse. The secret was a simple one – the tubes were mounted coaxially so that there were minimum stresses due to rotation of the shell, and the elements were so wispy-light that they didn't absorb much energy from the shock of firing. Other tubes were initially used in the prototypes, and the special proximity tubes were refinements of them.

The latest development is the traveling wave tube, used in the latest microwave systems. This one is a real darb. There is a spiral of tungsten (Wolfram) wire about the size and length of a screen-door spring. A signal starts at one end and is amplified in distributive fashion as it goes along, coming out the far end with considerable zap to it. I'm wrong: Make the inner diameter of the spiral more like a soda straw. An electron gun at the input end shoots a beam of electrons down the center of this spiral to a target at the far end. I don't know what the target voltage is – 1000 volts or more, I think. What keeps the beam from spreading? A strong magnetic field squeezes it into a narrow, tight beam. Now, signals in a wire transmission line travel slower than the same signals in free space, or near the velocity of light. So far as I know, the best you can do with an accelerated electron beam is about half that velocity. So the TW tube effectively slows the wave to considerably less than the electron beam velocity by making it follow a spiral, while the beam goes straight. And the fields of the traveling electrons, in sweeping the wave along faster than it would otherwise go, add power to it continuously from one end of the tube to the other. If the signal had to drag the electron beam along, it would *lose* power. Result: a very broad band, comparatively high-power amplifier that works in the higher GHz.

The tube itself is about 18 inches long, about an inch thick, with a swollen end where the gun is. No base, flexible leads. It looks like a fever thermometer for elephants.

I do not guarantee the accuracy of the sketchy explanation of the TW tube. I don't understand it myself, so that is the best I can come up with. But improving on it is not a project, it's a career.

The burden of my thesis is clear enough. These old devices may be moribund, but they're taking a long time to die. This vitality is due to their suitability for certain special jobs, and should keep them with us for those applications for many years to come. ■

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6 Digit Digital Clock Kit

We wanted **our word** to mean something to **you**. When we first introduced our clock we used such words as "impossible", "unbelievable bargain", "prime quality", and "unconditional money back guarantee." We anticipated selling several hundred kits. Your response to our clock has been fantastic. Now several thousand kits later, we hear such comments as "outstanding value", "exceptional service", "I can't believe it", etc. One enthusiastic customer even wrote saying it was "the best thing since bottled beer."

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1 - MM5314 National Clock Chip with socket
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1 - Filter Cap
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#TIS-75 but with an internal house number. TO-92 plastic case. N Channel, Junction type FET.
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Like 7805. 5VDC - 1 AMP output. Has TO-220 plastic power tab - 99c

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MC1469R. TO-66 9 Lead package. For 3 TO 30V Outputs. Provides 600 MA direct output or more by using an external power transistor. Reg. catalog $4 ea With specs. $1.95 ea.

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THE SUNTRONIX MODEL KBD IV Keyboard is ideally suited as a general purpose ASCII Keyboard for data terminal applications. This keyboard more than meets the needs of the data entry market for long life and reliability.

The KBD IV utilizes the 2 key rollover solid state read-only MOS memory allowing encoded outputs to be strobed out as each key is depressed. A second key may be depressed concurrent with the first, but the second key encoded output will not be strobed out until the first key is released. This feature prevents ambiguity of character codes as a result of two keys being depressed in rapid succession.

ELECTRICAL SPECIFICATIONS:

* Voltage requirements – +5.0 V and –12.0 V
* Power consumption – less than 200 mw
* Outputs – standard ASCII; 7 bits + strobe
* Negative or positive logic output, jumper selectable
* Output connector – standard 14 pin DIP IC socket
* Three modes – normal, shift & control

MECHANICAL FEATURES:

* Size – 12¼" x 6¾" x 2½"
* High grade glass epoxy PC board
* Keyboard ROM SMC KR2376 40 pin MOS
* Electronic shift lock, not mechanical
* Keyswitches one integral assembly, not individual keys
* Switches have four-finger phosphor bronze contacts with gold inlay
* Keycaps are 2-shot high strength ABS plastic

These keyboards are available off the shelf in two forms – fully assembled and unconditionally warranteed against defects in manufacture or materials for a full ninety days, or in the more economical kit version. Kit parts are fully warranteed against defects in manufacture or materials for a full ninety days. In either version, full instructions are supplied for operation, including specifications and data sheets. In the kit version, complete instructions are supplied for the assembly process. A reasonably competent technician can completely assemble and test this keyboard in one evening. All parts needed are included.

INTRODUCTORY PRICES

Factory assembled – $74.95 ppd.
Complete kit, w/instructions – $64.95 ppd.
Please add $1.00 handling per order.
Minimum order – $5.00

SUNTRONIX COMPANY

360 Merrimack St., Lawrence, Mass. 01843
(Telephone orders: 617-688-0751 603-434-4644)

The "Little Log" for 40 to 20m

by
Gordon Stewart VE4GS
26 Dominion Bay
Thompson, Manitoba
Canada R8N 1L3

This log-periodic type of antenna will likely be of interest to SWLs who have a couple of dipoles or random wires tied to their receivers. Although designed for 7 to 15 MHz as an experiment in compact log-antenna performance, it is usable for receiving from 6 to 16 MHz.

Using it for transmitting on 7 and 14 MHz it showed about 2.5:1 swr. The swr throughout the range varies more than one would like for transmitting use, but seems to cause no problem when receiving. I would describe the general receiving performance as a very good dipole on all frequencies in the range or a slightly degraded 2 element beam. The front to back ratio seems to vary from unity to about 12 dB, depending on the angle of the signal off the back. Fading seems to be less than when a dipole is used.

The poles used to support the antenna should be at least 30 feet high – 60 feet would be even better.

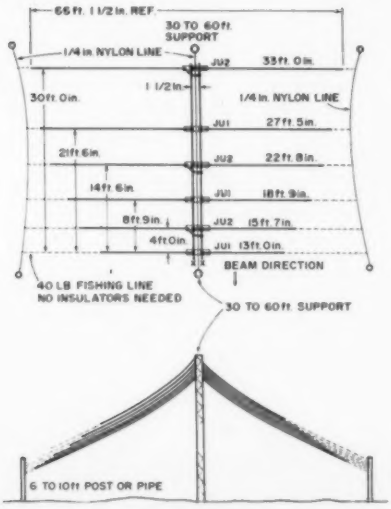


Figure 1.

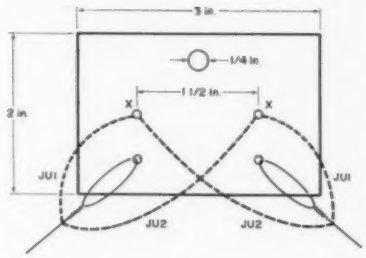


Figure 2: ¼" plexiglass (6 req'd., 1 at each center element).

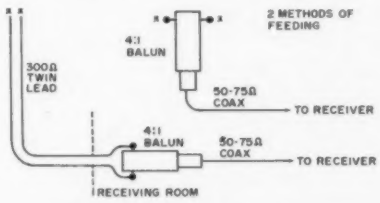


Figure 3: Two methods of feeding. Clean and solder all joints properly!

Be sure to transpose the element feeds as shown in Fig. 1.

The antenna can be fed through a 4:1 balun at the front element and coax run to the receiver. If a 300 Ohms line is available it could be run to the receiving room and then put into a 4:1 balun, with a length of coax used to the receiver. Because of the difficulty in making an all band antenna tuner, I suggest you use the balun, either ready made or from a kit which is available at a reasonable price.

This log, for casual use, represents the smallest size that is practical for the frequency range given – using performance versus size as the trade-off point. Wire size is not critical: #14 or #16 should be satisfactory.

Good listening! ■

Fading seems to be less than when a dipole is used . . .

Using A Bargain Surplus Keyboard

by
Cole Ellsworth W6OXP
10461 Dewey Dr.
Garden Grove CA 92640

I recently became the owner of an ASCII (American Standard Code for Information Interchange) encoded four-row keyboard purchased from a local parts emporium. Of relatively recent surplus vintage, it had originally been used in a computer terminal. The keyboard electronics consisted principally of a 40-pin LSI encoder chip similar to the General Instrument Corporation AY-5-2376. Several 7400 series chips composed the remainder of the circuit. Parallel format outputs included the 7-bit ASCII code, plus a parity bit, and the key-pressed signal (keyboard strobe). In addition, two key-switch non-encoded functions were available: "REPEAT" and "INT" (similar to WRU). All outputs were TTL-compatible positive true logic levels, although each of the eight data bit outputs was capable of driving only one TTL load.

The reason for acquiring the keyboard in the first place was to incorporate it in a computer terminal with video display to provide a man-microprocessor communications link. However, other applications came to mind, such as converting the 8-level ASCII code to Baudot 5-level code for amateur band use. And, should the FCC see fit to permit 8-level codes on the amateur frequencies, a proper interface would make such operation easy to accomplish. It became apparent that a number of keyboard support functions such as character counter, EOL indicator, repeat function generation, data output buffering, and keyboard strobe control would be required to provide maximum versatility in the aforementioned applications.

After an analysis of the keyboard support requirements and a projection of probable usage of the keyboard in varied applications, a logic diagram evolved that met all the requirements for my particular keyboard. It should be noted that keyboards, like canned soup, come in many varieties. Some designs have data outputs that are negative true TTL levels (mark = low level). Some have mixed outputs where the strobe is positive logic and the data bits are negative logic. Some recent designs have on-board LSI encoders that have a built-in repeat function (the strobe signal pulses at a ten Hz rate when a character key is held down more than about ½ second) while others do not even have a

repeat key. So as to make the support logic as versatile as possible, a number of options were provided in the final design and the result was named the Keyboard Interface – version 1 (KBI-1). Fig. 1 illustrates the interface unit logic diagram and connection to the keyboard. Fig. 2 shows the Digital Read Out (DRO-1) logic diagram which includes the EOL decoder.

Features

1. Provides buffered (up to 30 TTL loads) positive true data outputs (U3, U4) for the eight data bits with either positive true or negative true inputs.

2. Provides for strobed (3-state) outputs to allow connection to standard data bus, or normal 2-state outputs by means of jumper JM5.

3. Provides repeat function generator if desired (JM6).

4. Allows strobe and repeat functions from either positive or negative logic keyboard outputs (JM1, JM2, JM3, JM4).

5. Provides four variations in strobe pulse outputs:

a. Negative-going strobe pulse remaining at a low level until key is released (strap JM7 A to B).

b. Positive-going strobe pulse remaining at a high level until key is released (strap JM7 A to C).

c. Negative-going strobe pulse with variable delay and variable pulse width (strap JM7 A to D).

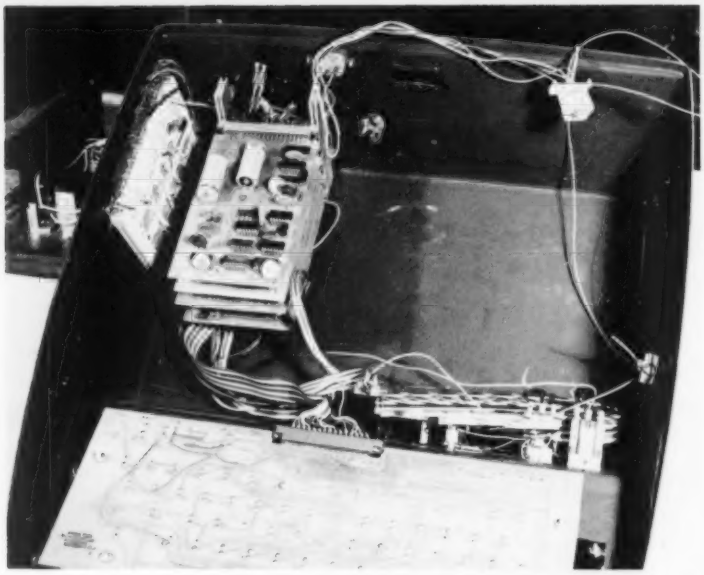
d. Same as letter c except positive-going strobe pulse (JM7 A to E).

6. Provides a character counter and LED display that counts only the printing ASCII characters plus space bar. Counter is reset to ØØ on receipt of ASCII LINE FEED function.

7. Provides End-Of-Line (EOL) indication at any desired character count. EOL indicator is also reset by the LINE FEED function.

Circuit Notes

For interface to keyboards with positive true logic outputs, U3 and U4 should be the 74367 non-inverting 3-state buffers. In this



Inside view of console showing method of mounting and interconnecting the five PCBs and keyboard. The PCB on the far left is a catch-all for peripheral drivers and other accessory functions.

case U3A and U4A are jumpered as follows: U3A – JM1 open, JM4 A to B; U4A – JM2 open, JM3 A to B. Note that in this configuration all keyboard data outputs must be positive logic including the strobe and repeat signals. There is no provision for handling negative logic strobe and repeat signals when data bits are positive logic. If required, outboard inverters could be used in this case.

For interface to keyboards with negative logic data outputs and *negative or positive* logic strobe and repeat signals, U3 and U4 are 74368 inverting buffers. Pinout and control levels are identical with the 74367. For a negative logic strobe from the keyboard, U4A JM2 is open and JM3 A to B. For positive logic strobe, JM2 is jumpered and JM3 A to C. Similar jumper conditions apply to U3A for negative or positive logic REPEAT signals.

If the keyboard has on-board repeat character function, then U1, U2A, and U3A are not required and may be disabled by connecting JM6 A to C (in this case U1 and associated capacitors and resistors need not be installed). If keyboard has the repeat function key but no repeat oscillator, connect JM6 A to B for a ten Hz pulsing of the keyboard strobe.

If normal non-strobed bipolar data outputs are desired (no high impedance third state), connect JM5 A to C. If 3-state data outputs are desired (U3 and U4 pass data only during presence of keyboard strobe pulse and outputs revert to a high impedance state when strobe pulse is not present), connect JM5 A to B. For initial tests of the KBI-1, JM5 should be strapped A to C.

The four variations in strobe signal output are selectable by JM7. Connect JM7 A to B for negative-going strobe staying low until key is released, JM7 A to C for inverse (positive-going strobe staying high until key is released). JM7 A to D and A to E select negative or positive strobe pulses as required. U14A R5 and C4 are selected to provide the

References

[1] Electronic Development, Inc., PO Box 951, Salem OR 97308.

[2] Hoff, Irvin M., "The Mainline UT-4," RTTY Journal, March, 1975, p. 4.

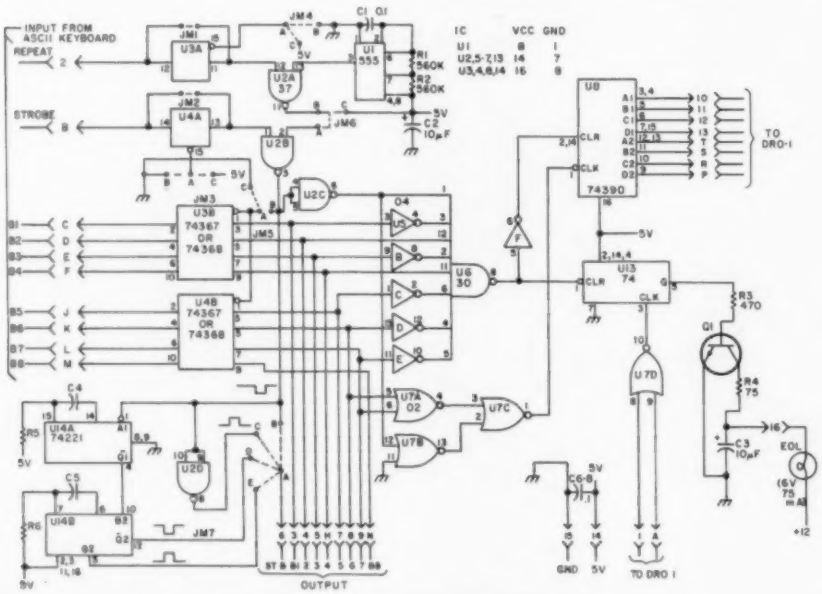


Fig. 1. Interface unit logic diagram and connection to keyboard.

required strobe delay, and U14B R6 and C5 are selected to provide the desired pulse width.

Thus, it is apparent that while the KBI-1 will provide interface for the majority of keyboard logic configurations, all possible permutations are not available. The KBI-1 is *not* directly compatible with non-coded keyboards, keyboards coded for IBM codes such as EBCDIC or SELECTRIC, or Keypunch (Hollerith) codes. In other words, before you consider use of the KBI-1, your keyboard must meet three conditions: 1. Outputs must be in a 7-bit parallel ASCII encoded format with or without parity bit. 2. Outputs must be TTL-compatible. 3. Must have a strobe (keypressed) signal output. The character counter section of the KBI-1 provides a two-digit display (ØØ to 99) of the number of printing characters (and space bar) generated. A portion of this circuit is located on the DRO-1 board (see Fig. 2). It will not count control functions. The display is reset to ØØ whenever LINE FEED key is pressed. EOL indication is provided by lamp DS-1. This circuit operates by detecting a preset number determined by strapping outputs of U11 and U12 to the inputs of U7D. Decimal thumbwheel switches (S1, S2) may be used for convenience in changing the set point if desired. Otherwise, straps are run from U7D inputs to the desired outputs on U11 and U12. At the preset count, the EOL indicator illuminates and remains illuminated until LINE FEED key is depressed.

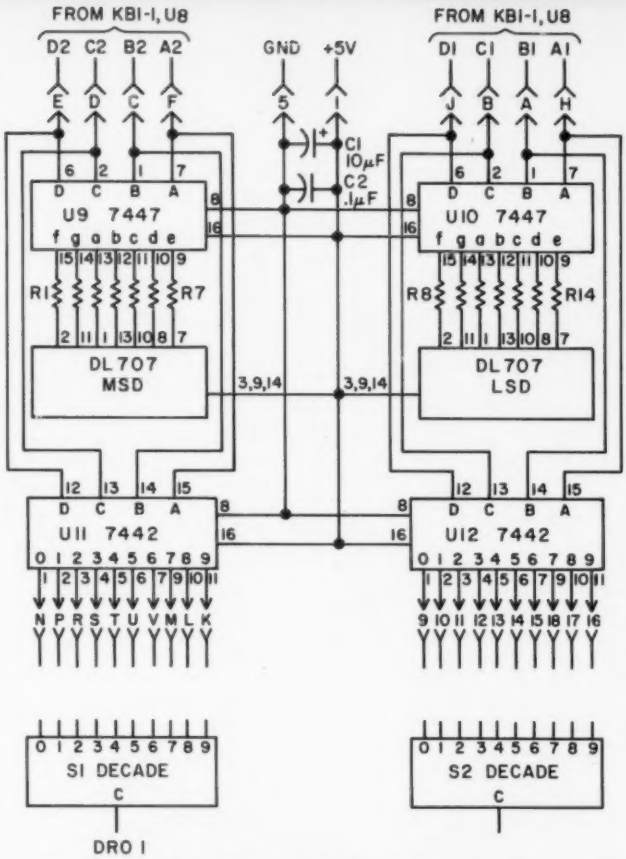
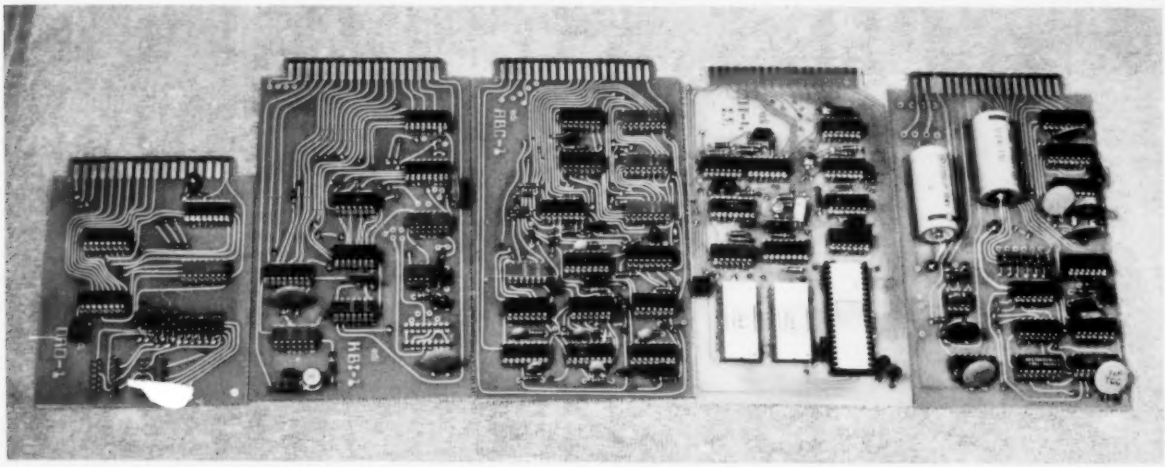


Fig. 2. Digital Read Out logic diagram, including EOL decoder.

Construction

Circuit layout and wiring is not critical provided normal rules of TTL logic are followed. Printed circuit boards greatly facilitate and speed construction and are recommended in particular to those who are not familiar with digital logic hardware. New, high quality components should be used to reduce or eliminate debugging problems. Surplus or reclaimed components may be used if you have the proper facilities



The five printed circuit boards from left to right: DRO-1 character counter and display driver (short board), KBI-1 interface, ABC-1 ASCII to Baudot converter, UT-4 i-f main board, UT-4 i-f auxiliary board.

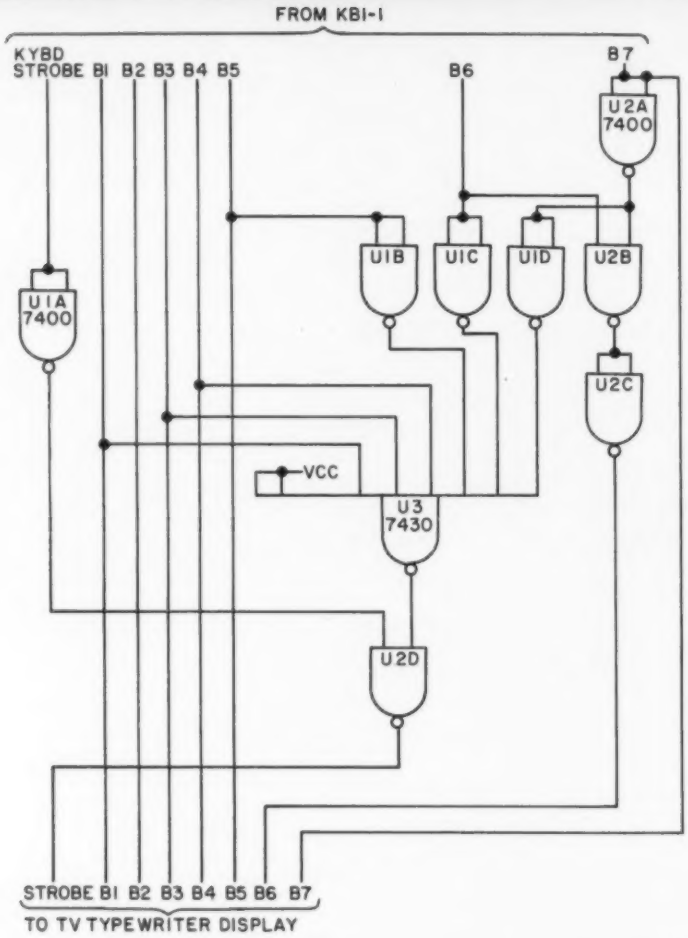


Fig. 3. Adaptor for driving SWTP TV Typewriter video display from KBI-1.

for testing. Sockets or Molex pins are recommended for the ICs as even brand new chips from a franchised distributor have been found defective. Check and double check the orientation of pin 1 of the chip with the socket.

C1, the timing capacitor for U1, may require selection to keep the repeat function rate at ten Hertz or less. R1 and R2 should be 5% ¼ Watt. R4 is required for the recommended EOL lamp and +12 volt supply. R4 may be replaced by a jumper if a 5 volt lamp and +5 volts are used in this application.

Printed Circuit Boards

Electronic Development Inc. (EDI)[1] of Salem, Oregon has been authorized to make the two printed circuit boards (KBI-1 and DRO-1) available for this project. No other sources of PCBs are expected to be available. PC boards only, or complete kits may be obtained. See EDI ads in *73* for description and availability. The boards are high quality epoxy glass, double-sided with plated-through holes and fit standard .156 inch spacing, 18-position double readout edge connectors. The edge connector references on the logic diagrams are identical with the EDI PCB edge connections.

Troubleshooting

At the time of this writing, three persons have built the KBI-1 and three different ASCII encoded keyboards have been used. These were surplus units manufactured by Clare-Pendar, Microswitch and Tektronix. Various problems were encountered in check-out including poor solder joints, missed solder points, trace to trace solder bridges, overloaded power supplies, and in several instances defective ICs were found. In each case a carefully thought out, logical approach to troubleshooting pinpointed the problem area. While a good triggered oscilloscope is a most useful adjunct to logic circuit troubleshooting, it should be pointed out that Peter K6SRG debugged and checked out early prototypes of the KBI-1, the ABC-1 ASCII to Baudot Converter, and UT-4 i-f circuits using nothing but a VOM (and an ice cube to find a temperature sensitive 74390!).

The KBI-1 was designed to be located in the immediate vicinity of the ASCII keyboard. Leads from the keyboard data outputs to the KBI-1 should not exceed 20 inches. Lines of greater length will cause ringing, especially on the keyboard strobe pulse. Ringing on the strobe pulse will cause multiple outputs from a single keystroke. Jim WA7ARI used a six foot cable between his keyboard and the KBI-1 but it was necessary to use type 75188 line drivers at the keyboard and 75189 line receivers at the KBI-1 inputs to prevent ringing. The same line length restrictions apply to the KBI-1 outputs. You must use transmission line techniques for any line over approximately 20 inches.

KBI-1 with TV Typewriter Display

Many RTTY enthusiasts have built the Southwest Technical Products Corp. (SWTP) "TV Typewriter" video display. Fig. 3 illustrates a special adaptor used between the KBI-1 output and the TV Typewriter input so that the video display has a CR/LF on receipt of LF instead of CR. The video display will still provide automatic CR/LF at the end of its 32 character line if an LF is not received prior to this point. Credit is due WA7ARI for developing this circuit.

Acknowledgements

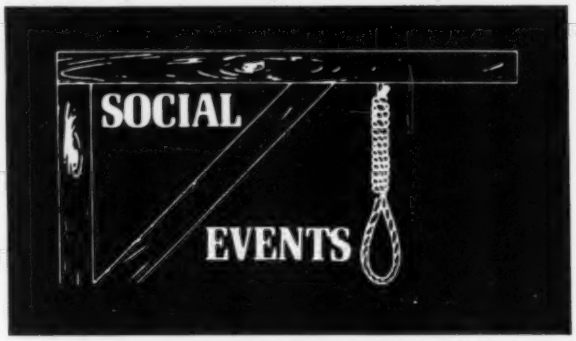
Recognition and appreciation of their contributions, comments and

encouragement are due members of the 3612.500 autostart net, in particular W6FFC, W6GQC, K6SRG, WB6WPX and WA7ARI. Thanks is also due those members of the net whose patience was sorely tried during the development period. Others who contributed comments and suggestions included K2SMN, WA5NYY and KL7HOH. The author extends his apologies to anyone whose contributions were overlooked.

ASCII to Baudot Conversion

A forthcoming article will describe an ASCII to Baudot converter (ABC-1) that converts ASCII data from the KBI-1 to parallel format Baudot 5-level code and outputs this data to a FIFO/UART combination such as the UT-4[2]. ■

KBI-1 Parts List			
U1	555	R1, 2	560k 5%
U2	7437	R3	470
U3, 4	74367 or 74368 (See text)	R4	75 ½ W
U5	7404	EOL lamp	6 V/75 mA
U6	7430	**DRO-1 Parts List**	
U7	7402	U9, 10	7447
U8	74390	U11, 12	7442
U13	7474	Display	DL707 or equiv.
U14	74221	R1-14	270 Ohm
C1, 6-8	0.1 uF	C1	10 mF, 16 V
C2, 3	10 uF, 16 volts	C2	0.1 mF
C4, 5	selected, see text	S1, 2	Decade thumbwheel switches



SOUTHFIELD MI
JAN 18

Southfield Amateur Radio Club's 10th Annual Swap and Shop, the largest in Michigan, will be held January 18, 1976 at Southfield High School, Ten Mile and Lahser Rds., Southfield, Michigan. Tickets $1.50. For more information regarding tickets and/or tables write to Mr. Robert Younkers, 24675 Lahser Rd., Southfield, Michigan 48075.

WAUKESHA WI
JAN 24

The 4th annual Midwinter Swapfest of the West Allis Radio Amateur Club will be Saturday, January 24, 1976 starting at 8 am at the Waukesha County Expo Center. This year in new larger building! Directions: I-94 to Waukesha Co. F, south to FT, west to Expo Center. Talk-in on 146.52 MHz. Tickets $1.50 advanced, $2.00 at door. (Dealers: advanced registration only.) Write: WARAC, P.O. Box 1072, Milwaukee WI 53201.

VERO BEACH FL
MAR 20-21

The Bi-Centennial Treasure Coast Hamfest will be held at the Vero Beach Community Center Saturday and Sunday, March 20 and 21, 1976. Sponsored by Vero Beach Amateur Radio Club, Inc., and St. Lucie Repeater Association, P.O. Box 3088, Vero Beach FL 32960.

WASHINGTON DC
MAR 24

1976 ARRL Technical Symposium on Mobile Communications will be held on the evening of Wednesday, March 24, 1976 at the Statler Hilton Hotel, Washington, DC. Areas of interest are: HF/VHF/UHF mobile communications, repeater technology and operations, signaling and control techniques, special mobile communications (AMSAT, ATV, RTTY, etc.); especially subjects of interest to both amateur and commercial mobile radio users. Summaries are due by February 1, 1976. Manuscripts, photo of author and biographical sketch of amateur/electronic background due by March 1, 1976. Write: Paul Rinaldo K4YKB, 1524 Springvale Ave., McLean VA 22101 or call (703) 356-8918 evenings.

ST. CLAIR SHORES MI
APR 4

The South Eastern Michigan Amateur Radio Association is holding its Eighteenth Annual SEMARA Swap 'N' Shop on April 4, 1976, from 8 am EST to 3 pm EST. It will be held at the South Lake High School in St. Clair Shores, Michigan, on the Southwest corner of Nine Mile Road and Mack Avenue.

HAM HELP

According to long-standing policy, *73 Magazine* makes a continual effort to match those in need of technical help or instruction with those who feel they can offer it. If you find yourself in one of these two categories, please do yourself and amateur radio a favor by contacting Ham Help, *73*, Peterborough NH 03458.

W5YF, the SMU ARS, is now offering Novice licensing mini-courses.
TIME: 9:30 am – 12 noon
DATES: Every 2nd, 3rd and 4th Saturday of the month.
WHERE: W5YF, Rm. 324, (Aruth Eng.) Southern Methodist Univ., Dallas TX 75275 (attn: WA2JRX).
PHONE: 692-3372
ADVANTAGES: Success rate running a mere 100%.

Got a tough schedule? We can accommodate you best of all. We're an F.B. station to learn on and get those first QSOs under your belt!

Bob Monaghan WA2JRX/5
Dept. of Anthropology
SMU
Dallas TX 75275

Help!

David Geerinck
920 Wolfe Road
Richmond IN 47374

I'd be happy to help anyone in any way to get his ticket.

Vick Martin WA6UOC
5834 Shoshone
Encino CA 91316
(213) 881-1058

I'd be glad to offer some HAM HELP.

Fred Layton
Rt. 18 Box 430
Olympia WA 98502

Our "Amateur Radio Education Association" started meeting in January, 1975, and now has about twenty active members.

While most of our members are already licensed, we would be very much interested in having non-licensed people, with an interest in amateur radio, get in touch with us.

The club has the potential to set up classes for these people and our instructor, William Farone (Extra Class), has the ability to set up a comprehensive instructional program in addition to being able to provide the motivation for learning.

Our base of operation is in Bergen County, which is in the northeastern part of New Jersey. For practical purposes, I think anyone living within a ten mile radius of the George Washington Bridge would be able to participate in our activities.

We would sincerely appreciate any help you could give us in recruiting new members – perhaps a mention of our organization in the "Ham Help" column would reach a number of both "would-be" and currently licensed amateurs.

William G. Lenz WN2VXL
538 Second Street
Palisades Park NJ 07650

Improve Your SSTV with The FRAMER

by
E. Sommerfield W2FJT
49 Spring Road
Poughkeepsie NY 12601

Next to multi-path sync problems, there is nothing more aggravating than the reception of only a portion of an SSTV picture (frame) completely out of vertical synchronization, and subsequently overlaid by a different portion of the same picture when the next frame starts.

This article describes a simple remedy that forces a vertical sync pulse at the beginning of each transmission, i.e., when the transmit/receive relay is activated. This will insure that when your transmission starts, your camera begins scanning from the beginning of a frame.

The Robot Research Inc. Model 80A SSTV camera was used as the example in this article, but the principle can be applied to other cameras that use the line frequency, together with a frequency divider, to obtain the vertical scan rate.

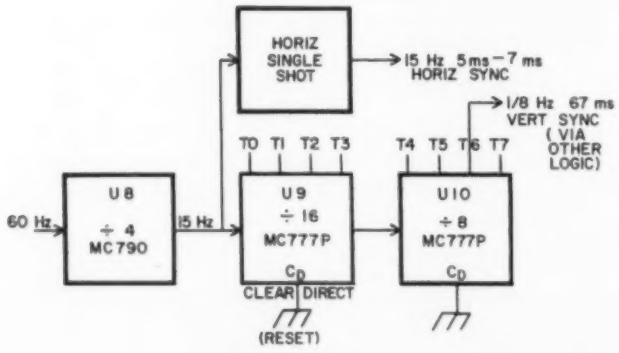


Fig. 1.

Fig. 1 shows a block diagram of the vertical timing chain of the Robot 80A SSTV camera; this is a common configuration for obtaining an 8 second vertical frame interval. Notice that the vertical sync pulse, which is used to reset the receiving monitor vertical sweep deflection, is free-running. If, for example, your transmission begins when T6 is "on" and T0-T5 are "off," then your picture would be transmitted starting at the center and continuing for one half a frame before a vertical sync pulse is transmitted. Likewise, at the monitor, one half a frame would be displayed starting wherever the monitor vertical deflection was at the time transmission began.

The simple solution to this problem, shown in Fig. 2, is to reset the vertical timing chain whenever a transmission begins, and hold it in the reset condition for the length of a vertical sync pulse: about 30 to 70 milliseconds. (Pulse times longer than 70 milliseconds will not adversely affect operation of either the camera or monitor.) When the 80A vertical timing chain is in the reset state, a vertical sync pulse is generated by the camera.

Fig. 3 shows a typical frequency divider. Most frequency dividers, also known as counters, have provision for at least one DIRECT input called a CLEAR DIRECT (Cd). A direct input is an input that overrides any clocking, toggle, or counting operations. Due to the grouping of the divider elements of 4 to a DIP module, each Cd input usually resets 4 divider elements. The

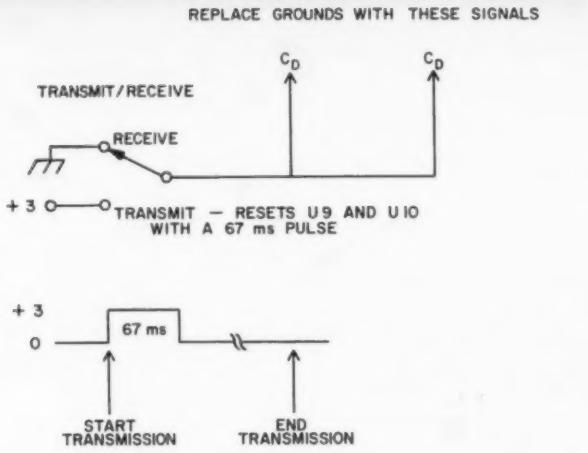


Fig. 2.

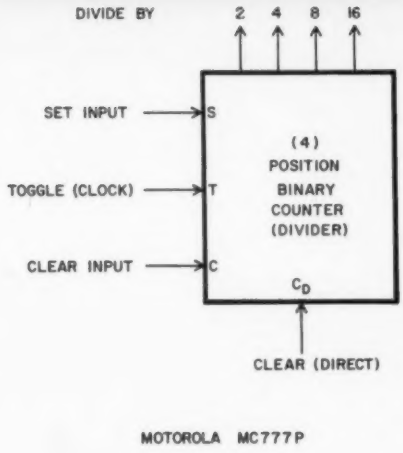


Fig. 3.

80A has 2 such divider modules, U9 and U10.

There are many electronic ways to generate a single vertical sync pulse in coincidence with the transmit/receive relay closure, but the relay circuit shown in Fig. 4 is the simplest and easiest to implement. An electronic version using the unused half of U4 was breadboarded and tested in the camera, but was not implemented due to the extensive modifications required to the U4 land pattern. It is shown in Fig. 5(a) for the reader who is inclined towards electronic-only circuits.

The relay circuit, shown in Fig. 4, operates as follows:

In receive mode, the relay K1 return path via the transmit/receive (T/R) relay is open, and C1 will charge to +15 volts through R1 in about one second. When the T/R relay is closed at the beginning of a transmission, C1 will discharge through the parallel combination of R1 and the resistance of the coil of relay K1. The value of C1 was chosen in conjunction with the 1000 Ohm relay coil resistance, so that that the current through relay K1 coil would not drop below 3 mA until about 70 ms after the T/R relay closed.

Who wants to hear, "Send me a few more frames, the first two were out of sync"?

Fig. 4(a). Original wiring.

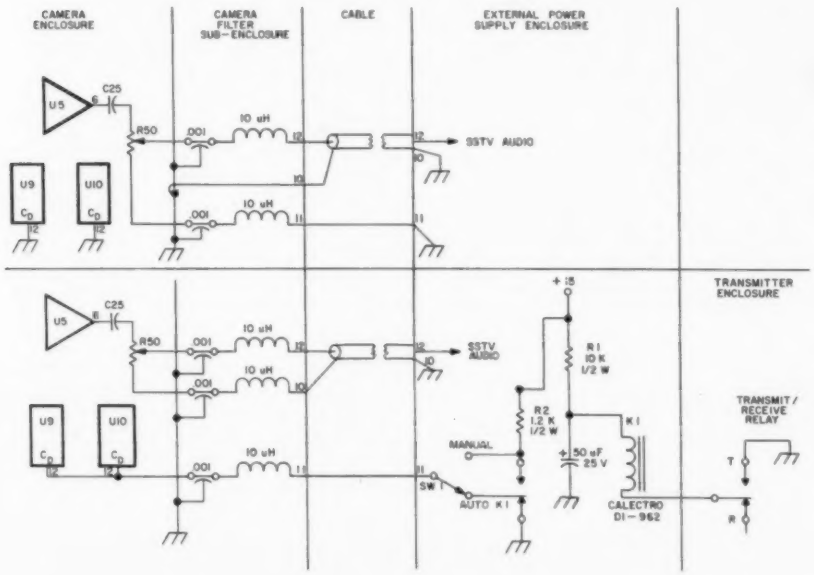


Fig. 4(b). Modified wiring.

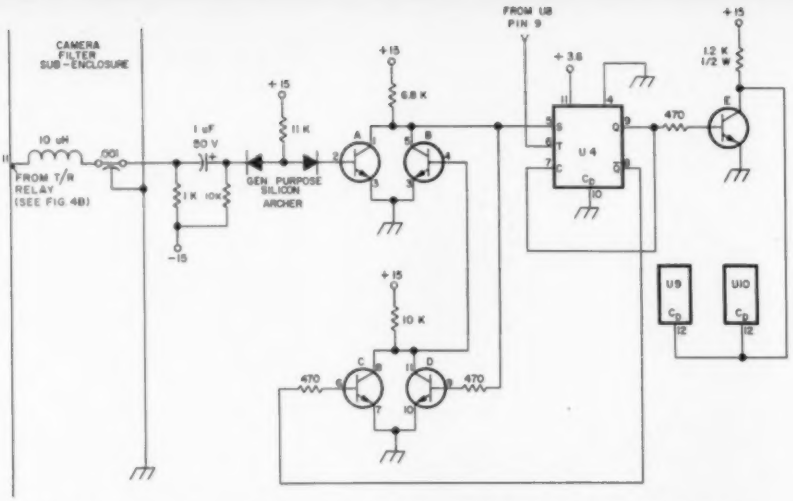


Fig. 5(a). All resistors ½ Watt. Transistors A, B, C, D and E are RCA CA-3046 five transistor array module.

Relay K1 will open when the current in its coil drops below 3 mA. C1 will discharge to +1.6 volts and stay at this value until the T/R relay opens. The current through K1, at +1.6 volts, is 1.6 mA, which is not sufficient to keep K1 closed. Relay K1, therefore, will close at the beginning of a transmission and reopen after about 70 ms.

When relay K1 closes, +15 volts is applied, via R2, to the Cd inputs of both U9 and U10, the vertical divider chain. When this occurs, all 8 counting elements of the divider chain are reset, and, as was mentioned earlier, the 80A generates a vertical sync pulse. The value of R2 was chosen so that the voltage on the Cd signal line is about +1 volt as required by the manufacturer's specification for the MC790P. The rearrangement of cable wires between Figs. 4(a) and 4(b) was necessary in order to obtain the wire for the reset line. The video output circuit is functionally the same in both circuits.

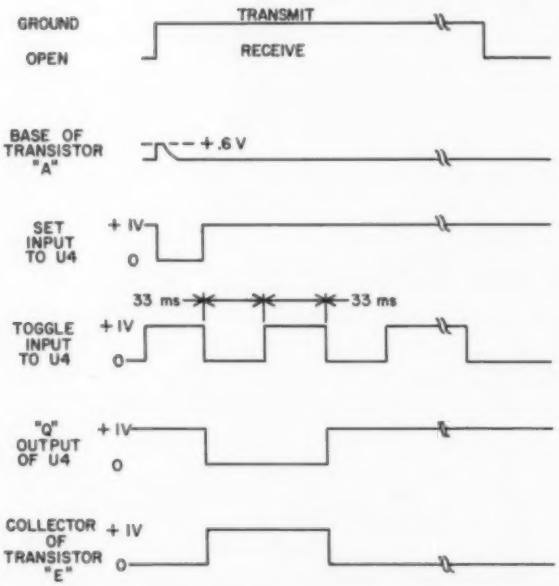


Fig. 5(b).

Those readers who are familiar with relay operation might question the lack of concern with relay contact bounce. Relay contact bounce is present of course, but the vertical sync filter in the monitor only passes sync pulses longer than about 30 ms. Contact bounce only lasts for about 10 ms to 20 ms, so no problem was experienced in this area.

Switch SW1, which is optional, allows manual reset of the counting chain. If SW1 is left in the manual position, 1200 Hz will be continuously generated. This 1200 Hz-only condition is useful for calibrating the 1200 Hz frequency.

The electronic circuit shown in Fig. 5(a) has been described in many publications, including the RTL Cookbook[1]. Its operation is summarized by the waveforms shown in Fig. 5(b).

Fig. 6 shows how to modify the printed circuit pattern in order to isolate the Cd input pins: pin 12 on U9 and pin 12 on U10.

Fig. 4(b) shows how pins 10, 11 and 12 on the 80A power plug sub-panel are modified to permit pin 11 to be used for the Cd reset signal line. The power plug connections at the power supply must also be modified as shown in Fig. 4(b).

Relay K1 should be located in the external power supply enclosure in order to avoid

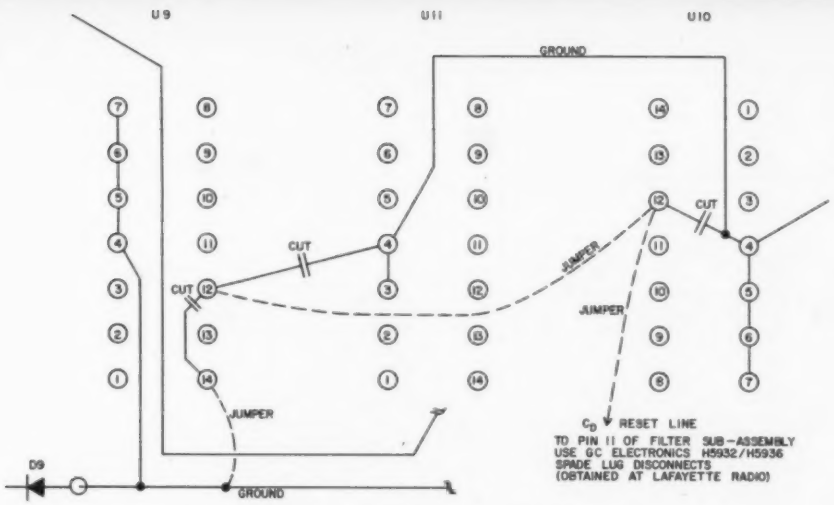


Fig. 6. Robot 80A SSTV Camera, wiring side of board.

transient current noise pulses on pin 5, the power supply ground wire to the 80A.

The addition of this FRAMER (FRAME Resetter) to the 80A lets you transmit more complete frames than was possible before; after all, who wants to hear "send me a few more frames, the first two were out of sync"?

The inclusion of the optional manual switch feature also eases the 1200 Hz calibration by permitting a continuous 1200 Hz signal generation.

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Reference

[1] *RTL Cookbook*, Donald E. Lancaster, Howard W. Sams & Co., Inc., page 126.

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The Experimenter's Dream Card

by
Robert J. Buckman K9AIY
PO Box 1471
Green Bay WI 54305

Most amateurs have had some experience with printed circuits or their predecessors, perfboard. This article summarizes my experience with printed circuitry and develops a general purpose card for amateur use.

The advantages of printed circuit cards for breadboarding or permanent construction are many! Serviceability, dense packaging, reproducibility and reduced wire lengths for improved high frequency response are examples. In amateur projects involving integrated circuits, some sort of circuit card is a must.

Industry has used printed circuits for years and has adopted several standards in sizes and board edge pin placement. Card cages are available which will accept these standard size cards and allow very dense packaging. Standard individual cards with identical circuits on them allow swapping out cards during troubleshooting until the faulty card is located.

In amateur projects involving integrated circuits, some sort of circuit card is a must . . .

Many companies sell standard and special purpose cards either blank or with a pattern etched on them. If you have priced the cards available through Vector, Cambion, Circuit-Stik, EECO or the others, you can see why this article was written.

Card edge connectors are another expensive item; generally, the more pins you try to cram into a socket, and the closer together they must be, the more the connector will cost. We amateurs with limited budgets must find the cheapest connector that will do the job without pricing the project out of sight.

Lately, the simpler and smaller-sized card edge connectors have been turning up at hamfests and surplus markets at substantial savings. This fact is the primary motivation for the circuit cards developed here.

Industry standard card sizes start around 3" in width; several manufacturers produce cards with 4½", 6", and 8½" width. Lengths are not so standard, with 4½" a minimum and 17½" a maximum. Before deciding on a size, let's review the types of circuit card fabrication and applicability to amateur projects.

There are three basic methods of applying a circuit pattern to a card blank: direct etch where the desired copper paths are covered with tape or paint resist before etching, photographic sensitization of a treated board (photoetch) prior to etching, and additive processes where the pattern is added to a blank board (Circuit-Stik is the best example although some companies are plating the desired patterns onto a board). Direct etch is limited by the dexterity of the applier and to simple circuits that are not densely packed. Circuit-Stik is fast but expensive. Photoetch is the choice remaining and, once you get started, relatively inexpensive. This article uses the photoetch technique.

The card stock available will also determine the techniques that are feasible for the amateur. The first card stock to be available at reasonably low prices was the epoxy paper circuit board which came with

one or both sides coated with copper and usually undrilled. Epoxy glass boards are now available, are reasonably priced (about a penny a square inch or less), and are less susceptible to moisture damage. Pre-drilled or punched card stock is available with holes on a standard grid, either 0.20 inch or 0.10 inch. The 0.10 inch perfboard is ideal for integrated circuit cards and only slightly more expensive. Cards are also available with photosensitive coatings for slightly more. I prefer to coat my own boards but that takes practice since it is possible to produce a too thick or too thin coating.

In designing a general purpose card, you must consider both its uses and the rough-order-of-magnitude quantity of boards to be produced. I presently have over twenty projects in some phase of design or construction. Many of these projects will use several circuit boards. A review of these projects shows many to be entirely digital, or at least, use the dual-in-line (DIP) package.

My circuit card is based then on the standard DIP outline. With all the different configurations and pin counts (8, 14, 16, 18 and 24), etching power buses on the card has several disadvantages. If many DIP chips must be accommodated, say thirty or so, the number of holes to be drilled will be over 300 without considering interconnections or discrete components! Test points, trimpots, switches, lamps and LEDs must be considered and allowed for. Finally, sockets and input/output connections may be needed.

A review and design tradeoff of all the above considerations have resulted in the general purpose card described here. The basic card is epoxy paper perfboard with 0.10 inch grid holes, copperclad on one side,

If you have priced the commercially available cards, you can see why this article was written . . .

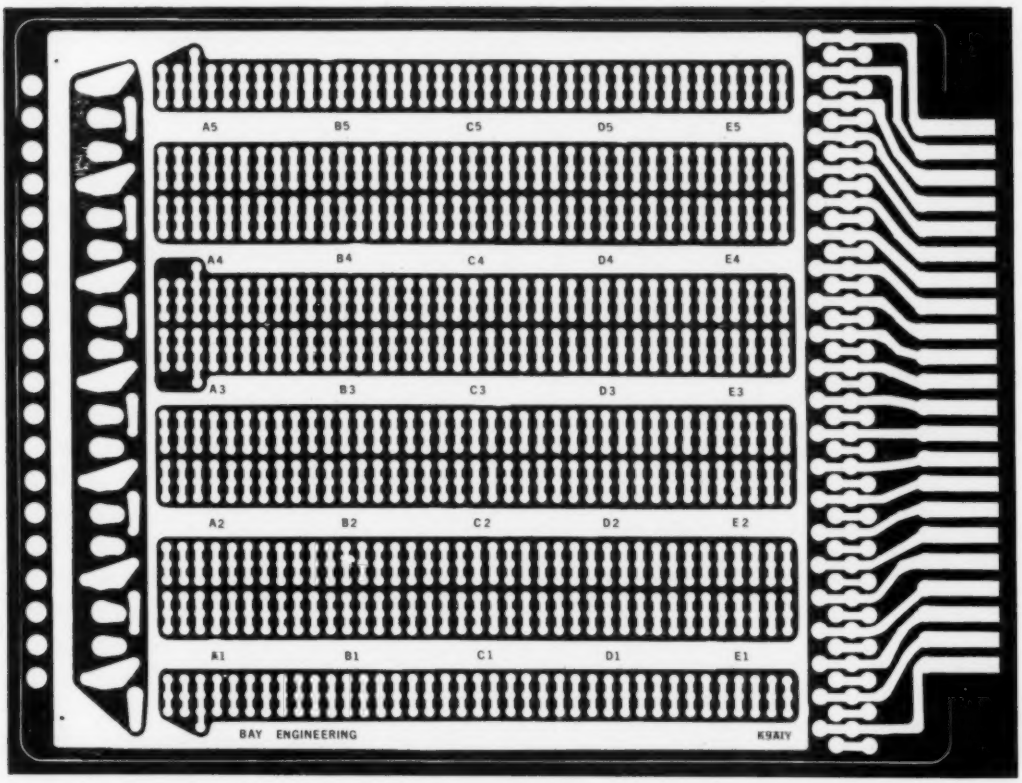

Fig. 1. Full size copper-side foil pattern.

4½" wide and 6" long. Vector makes the boards I have used (part number 64P44-062EPC1), but other manufacturers make similar boards. Fig. 1 is the full size copper-side foil pattern and Fig. 2 is a component-side overlay showing one of the many configurations possible.

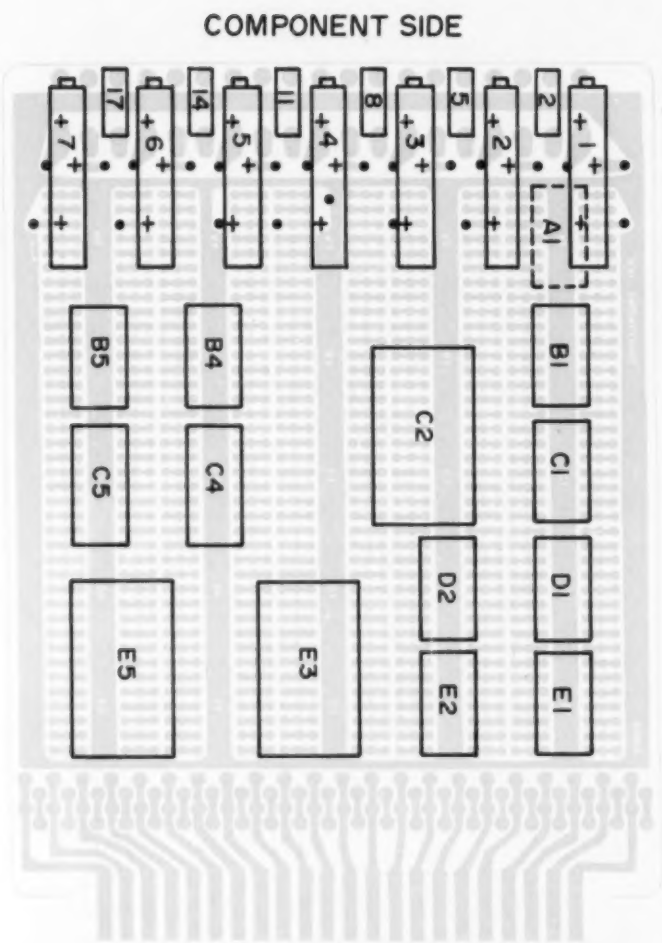

Fig. 2. Component-side view of one example configuration.

This board will hold 25 14-pin DIP chips, six test points and 7 trimpots simultaneously. A maximum of 30 14-pin chips and 19 test points may be mounted. 24-pin DIP chips also fit on this board to a maximum of 9 24-pin packages. 22 input/output pins, spaced 5/32 (0.156) inch apart form the board edge connector. If a double-sided board edge connector is desired, a Circuit-Stik connector pattern subelement (part number 1365-005) can be overlaid on the component side and will mate with pads already provided on the foil side. The dual-sided connector will provide 44 independent input/output connections; however, the older 22 pin board edge connectors are more readily available than their dual-sided brothers.

The two additional pads connected to each DIP pin allow a daisy-chain connection to each pin (one wire in, one wire out). Since only a ground bus is etched on the foil side, the types of ICs are not restricted to those with power connections on any particular pins. None of the commercially manufactured cards I have seen allow mixtures of 14, 16 and 24 pin DIP chips or allow test points and trimpots simultaneously.

A variation of this board, the same physical size but without foil or allowances for trimpots or test points, has been used with wirewrap sockets which are finally becoming available. A plastic hand wirewrap tool has become available from Cambion (part number 435-1816-01-00-16) for the nominal price of two bucks. Up to 45 14-pin wirewrap sockets may be stuffed on a board this size. Unless the complete project will fit on this board, the 44 maximum input/output connections will restrict the number of ICs that can be used. The cards above can be constructed for under five dollars in quantity and are about half the price of a similar commercially manufactured card. ■

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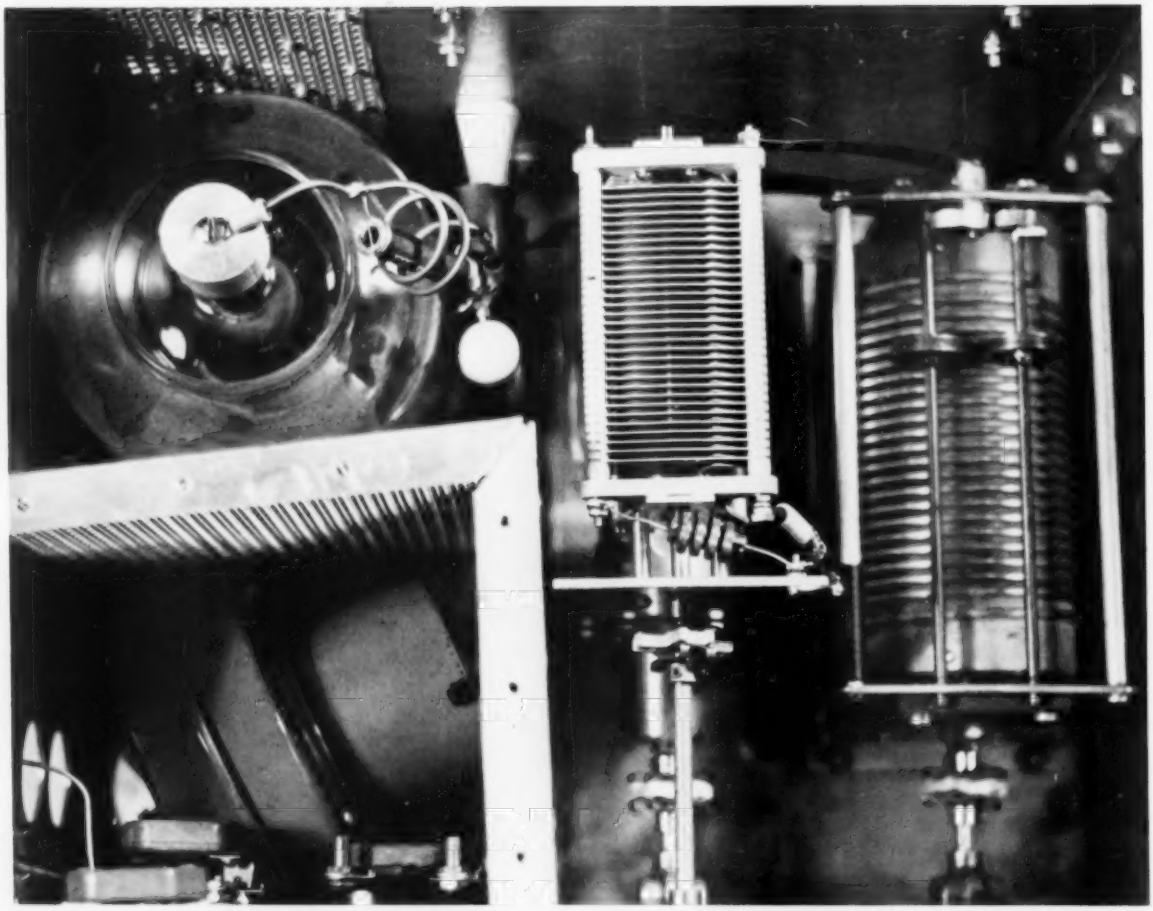


Amplifier plate circuit.

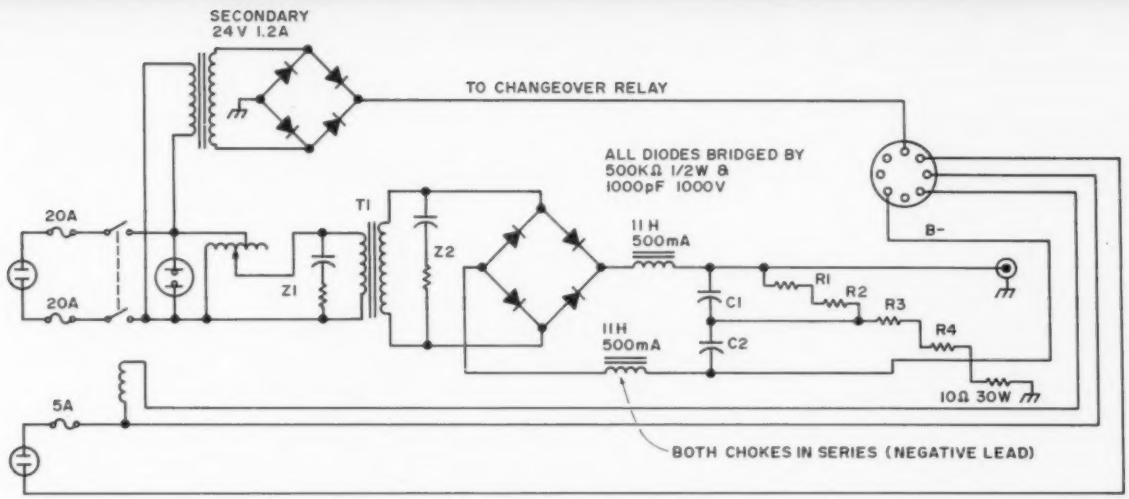


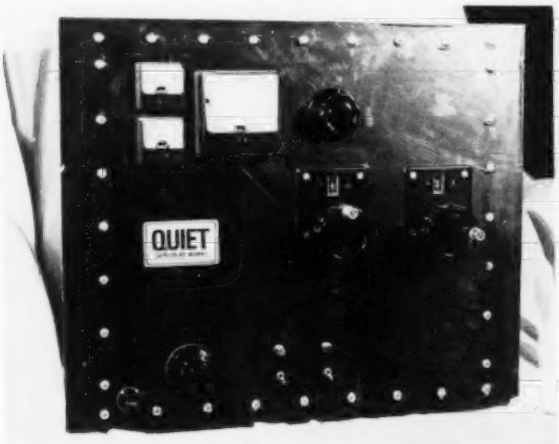
Fig. 1. High voltage power supply. Note that the high voltage bridge actually has 40 diodes.

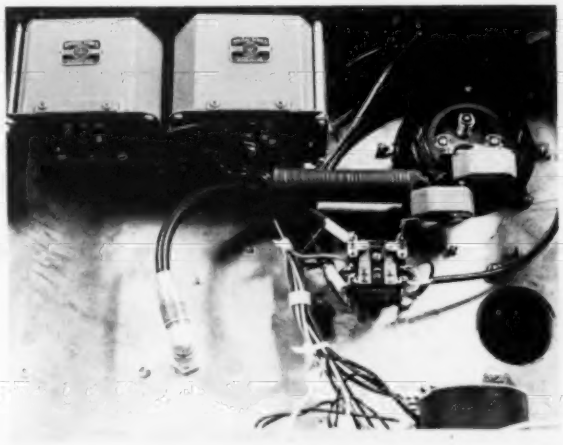
The design of this grounded-grid linear allows the use of either the 3-1000Z or 4-1000A. The components were chosen to operate well within their limits, my monetary possibilities, and to offer the best voltage regulation in the power supply. Large overall size, weight and no portability resulted, but then those weren't factors here.

Filament Circuit

Two 7.5 volt, 10 Amp transformers that just fit under the four inch chassis were found in unused surplus for a good price and work well. Each side of the filament is fed through a bifilar wound choke. Each choke is wound with #10 wire on the whole length of an Amidon ferrite rod – the kind available in the Amidon kit. This heavy construction results in very little loss of voltage through the chokes. The face of the filament voltmeter is marked to give precise setting of the voltage. The variac in the line offers one the ability to slowly bring the filament up to temperature. This procedure is highly recommended by Erwis Isgitt W7SLC of Eimac in Salt Lake City, to improve tube life. Be sure to fuse the variac, in this case at 1.6 Amps. The B-return is to only one of the two transformers to avoid difficulties with balancing.

In this linear there is no tuned input, but if matching presents a problem or there are not at least 125 Watts available for drive, put one in. Note the chart for a tuned input to a 4-1000A at plate potential of 5 kV.





Front panel of amplifier – note turns counter knobs; underside of chassis showing filament transformers, tube socket, and relay.

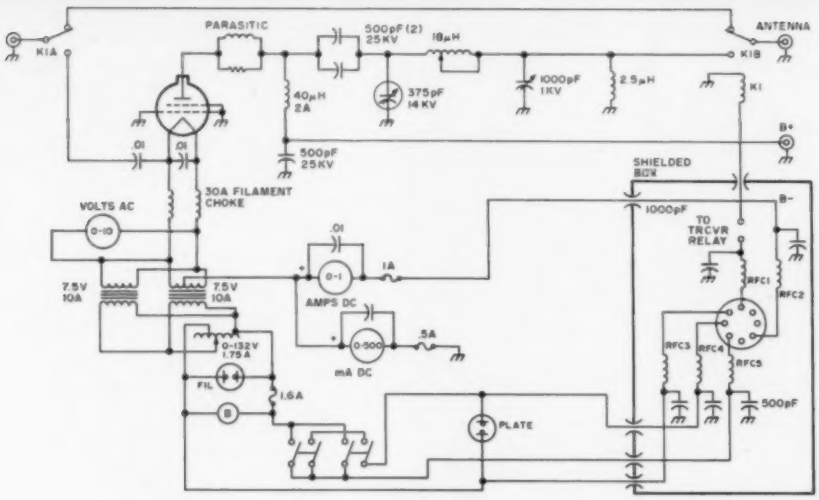


Fig. 2. Schematic of "Super Bottle" amplifier.

Tank Circuit

William Deane built the two Amp plate choke which is surrounded on one side by the tube and on the other by the stacked tune and load capacitors. The roller coil will provide about 18 uH maximum. The loading capacitor is not sufficient for 80 meters with the triode, and the coil is marginal for the tetrode on 80. For best results, Q = 12, the coil should have about 20 uH and the loading capacitor about 1800 pF.

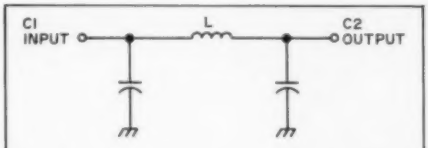
Metering

Separate meters for plate current, plate voltage, grid current, and filament voltage add considerably to the overall cost, but there are times when one needs all values at a glance. Fuses in the lines to the plate and grid current meters save meters. My first linear blew both meters when the B+ shorted through a faulty component. Since then test and "burn" trials have blown fuses instead of meters. The meters are bypassed with mica, not ceramic, capacitors, as the latter are not always reliable in rf applications. The meters are in the same compartment with the blower and all leads are "fed-through" with capacitors into the next compartment.

Detail of panel meters.

Power Supply

The power supply is enormous and very heavy! After the plate relay, the ac is fed to the variac, which is turned up slowly to avoid surging. The plate transformer, as well as the two chokes, is from a BC-610 power supply and is rated at about 5 kV at .5 Amp continuous duty. The full wave bridge rectifier has ten kV in each leg built of 40



Band	Input C1	Turns L	Output C2
80	–	16 of #18	470
40	512	13 of #16	322
20	337	9 of #14	213
15	247	6 of #13	190
10	227	4 of #13	190

The coil forms should be half inch slug tuned (look in ARRL Handbook).

Table 1. Chart of the input values for the 4-1000A.

Parts List

C1, C2 – 120 uF 3000 V dc isolated from ground.
R1, R2, R3, R4 – 80 kΩ 250 Watts.
T1 – 105, 115 V ac primary 2500, 2000, 0, 2000, 2500 volt secondary. Rated at ≈ 500 mills continuous duty in full wave bridge.
K1 – 24 V dc 15 Amp contacts.
Variac – 0-140 V ac 20 Amps.
Z1 – .01 at 400 V ac in series with 100Ω 10 Watts or arc suppressor.
Z2 – .001 at 25kV in series with 200Ω 25 Watts or arc suppressor.
RFC1-5 – 18 turns #14 enam. wire, close-wound, ½" dia.

1000 piv 2.5 Amp diodes and associated RC networks. The chokes are each rated at 11 Henrys at 500 mills and insulated at 10 kV, but just the same are in the negative lead. The oil-filled filter capacitors are insulated from ground, similar to electrolytic strings, since they are rated at only 3,000 WV dc and peak voltage is about 5,000. The bleeder resistance is a string of four 80k Ohm 250 Watt ceramic covered large economy size units. Two would do, but then the shack would need no heater either.

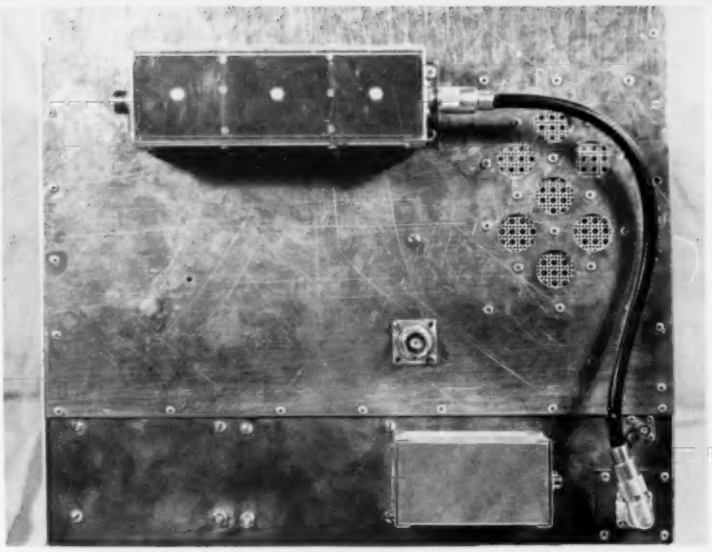
The chokes are tuned with an oil-filled .05 uF, 10 kV capacitor so that the bleeder can be small, yet the voltage doesn't soar when there is no load on the supply. Here is a simple way to tune a choke: LC = 1.77 (or close will do). The value of a choke, non-swinging, increases when the load current is low. Figure about two times rated value for good quality chokes. Thus, in this case, 1.77 divided by about 2 x 11 (two chokes in series) or 20 = .08 thus .05 is ok. The closer the better; experiment to get the best regulation. L is in Henrys, C in uF.

Control Circuitry

The wiring of the filament and plate relay switches is copied from Max Burggraff's design (note references). No matter which switch is thrown first, the filament is turned on, and both have to be thrown to energize the plate relay. The changeover relay is suitable for transceiver operation. A three pole relay would be useful for biasing the triode under idling conditions, but the 4-1000A only draws about 120 mills at 5 kV, not enough to bother the tetrode.

Miscellany

The components were arranged so that the leads are as short as possible, yet the front panel is not unsatisfactory. The meters are bunched to make shielding easier. I tried to cover a scratched front panel with a very shiny, gold contact paper. Other than the fact that the paper bunched up under the screw heads, it is tolerable. However, I won't do it that way again. The cabinet is built up around a steel chassis (for strength), plated copper. Other than the chassis all the sides are aluminum. I also used aluminum rivets where the joints would not restrict servicing.



Rear view.

Comment

"Super Bottle" works very well with either tube in the socket, though bias will keep the triode much cooler during standby. Efficiency is on the order of 60% on 20, 40 and 80 meters and less on 15 and 10, due to the less than optimum coil at higher frequencies. The linear is clean according to my monitor scope and the wattmeter indicates a quite noticeable difference over the transceiver. The on-the-air reports agree. I will be glad to respond to any correspondence accompanied by an SASE.

Acknowledgement

I thank the following: From Eimac, Salt Lake City, for the technical assistance, Vern Campbell K7BYQ and Erwis Isgitt W7SLC; friends who listened and suggested, Max Burggraff WA7AIA and Phil Bullock W7VEO; John Lloyd, Jr. WA7GWU who helped with suggestions throughout construction and testing; Fred Roberts WA7NKS, neighbor and photographer. I especially appreciate the tolerance of wife and children because the mess in the playroom stayed for long periods of time between cleanups. ■

References

Burggraff, Max, "Big Signal – Good Looks," *73*, September 1969, 124-128.
Brown, Fred, "Tuned Choke Input," *CQ*, October 1967, 80.
Deane, William, 8831 Sovereign Rd., San Diego CA 92123.
Johnson, Neil, "Tuned Filter Chokes – The Easy Way," *73*, December 1969, 18-21.

"We Must Abandon Ship... Help..."

by
Albert Coya WB4SNC
1710 S.W. 83rd Ct.
Miami FL 33155

It was cold and windy, that New Year's Eve, also a "straight key night." I went down to the shack and took the old 50 Watts rig from the shelf. This transmitter was built by my uncle in the early 1930s. I remember the many hours I spent in his shack, trying to tell the dots from the dashes.

The strong smell of the bakelite fired my imagination. I removed the dust from the 46ers and looked around for the power supply. I wondered if the old rig still worked.

An exciting idea came to my mind. How about using this transmitter on *straight key night?* It certainly would be interesting to find out the kind of reports I would get from the fellows.

I found the power supply and plugged it in and then proceeded to check the voltages with the VTVM. To my surprise everything was okay. I found the crystals and sets of coils for 80 and 160m in a box. The 40m coils were already plugged in the rig.

I hooked up the power supply and one of the 40m crystals. Before turning on the rig I took my grid dip meter and tuned the stages to the crystal frequency, then I hooked my Cantenna to the output.

The great moment came. I fired up the rig! The filaments glowed with a pale reddish color. The ammeter has a plug, and jacks to check grid and plate current where installed in the front panel. I plugged my old brass key in the proper jack and used my receiver with the antenna disconnected to check if the rig was working. I keyed and tuned the plate to a 50 mA dip. I moved the receiver's dial until a loud note came from the speaker. It was working! The old son of a gun was working! I couldn't believe my ears! For the on the air test I had to improvise a primitive antenna switch. This task took me only twenty minutes, but it seemed like an eternity.

Finally, I was ready to go airborne. I listened in the crystal frequency, and fortunately it was clear. I didn't want to step into anybody's QSO without invitation, so, with trembling hand I sent a QRZ and my call letters. I was used to using a bug and fumbled badly with the straight key. Nobody answered. Then I launched my first CQ. By the time I signed K my fist was getting the old feeling of the straight key. I switched the antenna to the receiver and searched for a signal. Nothing, except some familiar QRN. After my third or fourth try there came an answer. I scribbled his call in my pad and proceeded to switch the antenna. It was a 4 call, so he was not too far, but who cared if he was just around the corner? The great thing was that somebody heard the old rig! I gave him the RST report and the routine stuff, switched the antenna and listened.

"Sorry OM but you have something that sounds like key clicks. Your RST is 569 with QRN. The clicks are not really bad and I hope you can fix it."

I told him the kind of rig I was using and that I was going to try to solve the problem. After signing out and wishing him a Happy New Year, my XYL came into the shack like a tornado: "You are messing up my TV.

You told me that would never happen again! Guy Lombardo has streaks all over his face!"

"But, honey bunch," I told her, "the old man has been playing with his band for quite a few New Year's Eves, and it's normal to have those wrinkles in his face. . .maybe he needs a face lift. . ." It was pretty lame.

"This is not the kind of wrinkle you can fix with silicone. . .maybe one of your funny looking filters. . ."

I knew she was right. So back to the old drawing board. With no shielding, and all the long leads scrambling like snakes over the wood board, the old rig was radiating all kinds of parasitic oscillations.

I wanted to work straight key night and I knew to dress those leads and fix the trouble would take hours. But I decided to do it. A couple of capacitors added to the filament of the oscillator tube and shortening the lead to the screen capacitor did the job. I was back on the air in less than an hour.

I switched to 80m and worked stations as far as New York. I was having a ball every time I told the fellows about the old rig. The clicks reported in my first QSO were almost nothing after placing a capacitor shunted by a resistor across the key contacts.

After signing out with a fellow in North Carolina I heard my letters being called. It was a very weak signal. I couldn't copy his call letters after I signed "QRZ?"

I plugged the "cans" and tried to retune the receiver. Holding the "cans" to my ears I heard my call letters again and broken words: "...are...danger... please...help...This is maritime mobile..."

The QRN was tremendous. I couldn't believe my ears. It had to be a prank. A ship in distress and calling in the ham bands? Impossible!

I banged the antenna switch in the transmitting position: "Where are you? The name of the ship, please?" I repeated the message a few times very slowly and signed "BK."

The answer came back, "Ship name is... bound for Cape of Good Hope. Position is...° West and...° South. We must aban-

don ship...five feet of water in the bilge...please contact... Guard..."

And the signal faded away...

I fumbled with the knobs trying to pick up the weak CW signal. The erratic dash and dots came back:

"He is beserk... will kill all of us..."

A burst of static whipped him off.

Holy Neptune! What was going on on that ship? Was he talking about the storm or a member of the crew?

Through the QRM the CW signal came back once more. "The skipper is dead ... please call... that man is crazy... BK..."

I slammed the antenna switch to transmit. "The name of the ship and position again, please!" repeated the same many times, signing my letters and K.

"Position is ... °South ... name of the ship is 'Flying Dutchman' ..."

The "Flying Dutchman"? Somebody must be pulling my leg. Or was it a real ship whose owners had had the bad taste to name their ship after that legendary ghost?

Again and again I tried to contact my evasive operator without success.

I went to bed and the lights of the New Year found me with my eyes open, looking at the ceiling. Had to be a prank, I told myself ... ■

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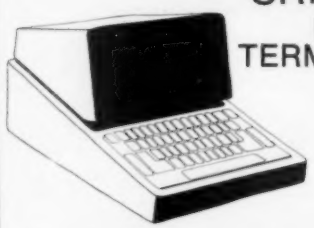

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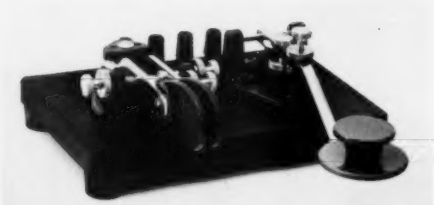

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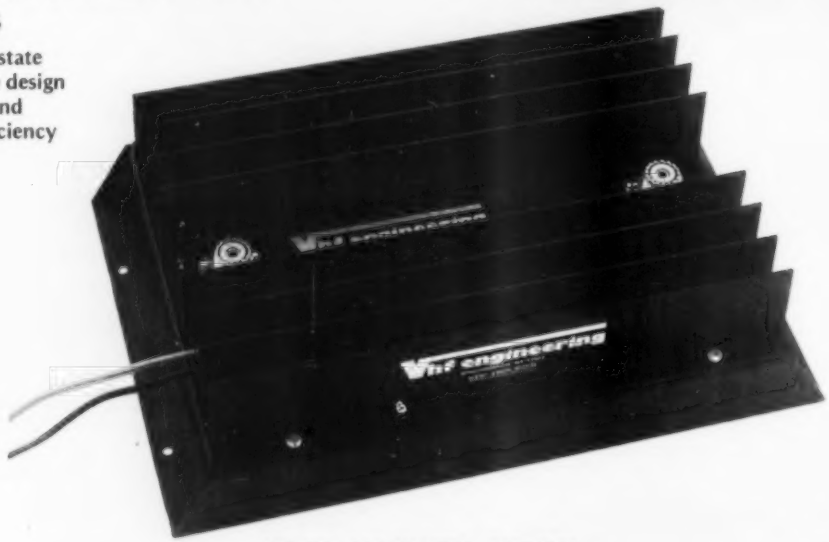

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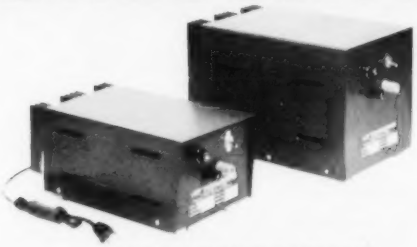

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PS-12C SPECIFICATIONS

Voltage Output: adjustable between 12-14V.
Load Regulation: 2 per cent from no load to 10 amps.
Current Output: 12 amps intermittent (50% duty cycle)
10 amps continuous.
Current Limiting: maximum short circuit current 12 amps.
Ripple: 50 mV at 10 amps.
Weight: 11-1/2 pounds.
Size: 11-1/4" x 5-1/2" x 4-3/4"
Kit $79.95
Factory wired and tested $94.95

PS-25C SPECIFICATIONS

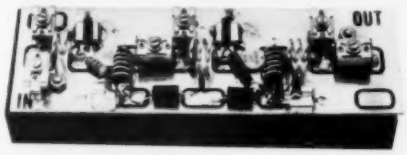
Voltage Output: adjustable between 10-15V.
Load Regulation: 2% from no load to 20 amps.
Current Output: 25 amps intermittent (50% duty cycle)
20 amps continuous.
Over Current and Voltage Protected
maximum short circuit current 2 amps
Ripple: 50 mV at 20 amps.
Weight: 20-1/2 pounds.
Size: 12-1/4" x 6-3/4" x 7-1/2"
Kit $129.95
Factory wired and tested $149.95

RF POWER AMPLIFIERS

Power boosters for 2 meters, 220 Mhz and 432 Mhz, solid state Class C using balanced emitter transistors for long life and high SWR protection. For FM mobile or fixed operation.

PA2501H - PA4010H

PA144/15 – PA144/25 – PA220/15 – PA432/10



15 WATT POWER AMPLIFIERS

SPECIFICATIONS: POWER GAIN; 12 db nominal, INPUT POWER; 2 watts max., INPUT VOLTAGE; 12 to 14 volts DC negative ground, INPUT CURRENT; 4 amps max., STANDBY CURRENT; virtually insiginificant, INSERTION LOSS; less than 1 db on receive, DUTY CYCLE; 50% or less.

Complete Kit consists of drilled glass PC Board, heat sink, all components, case, connectors, and solid state automatic switching. Basic Kit is the same less case, connectors, and switching.

PA144/15 – Basic Kit $39.95
PA220/15 – Basic Kit 220 MHZ $39.95
PA432/10 – Basic Kit 432 MHZ $49.95

25 WATT POWER AMPLIFIERS

SPECIFICATIONS: POWER GAIN; 15 db nominal, INPUT POWER; 4 watts max., INPUT CURRENT; 7 amps max., ALL OTHER SPECS; same as PA-1501 H.

PA2501 H – Complete Kit $59.95
Wired and Tested $74.95
PA144/25 – Basic Kit $49.95

40 WATT POWER AMPLIFIERS

A one stage 2 Meter amplifier with 6 db gain. 10 Watts input – 40 Watts output. Relay switching. Case included (same as PA1501 H).

PA4010 H – Complete Kit $59.95
Wired and Tested $79.95

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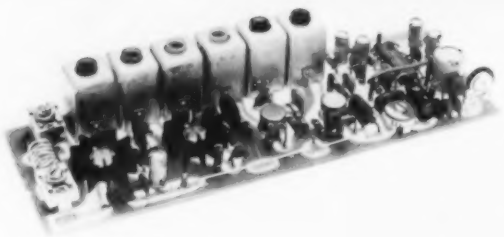
TRANSMITTER KITS



TX-144B and TX-220B measure 2" x 6" x 1"
TX-432 measures 2" x 7-1/2" x 1"

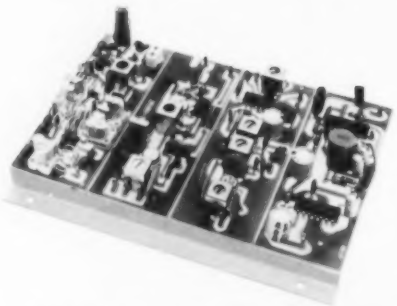
A one watt exciter using four RF transistors, two diodes, and one integrated circuit. The RF transistors are operating well below their ratings allowing long keying periods without damage. The exciter may be used alone as a transmitter or with our PA Series amplifiers for a 15 or 25 watt station. Some of the features are:

- Nominal output 1 watt
- Deviation adjustable to 7 KHz
- IC audio with clipping and active filter
- All spurious outputs down 30db or more
- Temperature compensation crystal trimmer
- Zener regulated oscillator
- Uses readily available 12 or 18 MHz crystals (18MHz for 220 and 432)
- All tuning coils prewound
- Predrilled and tinned G-10 Circuit board
- Easily built and tuned in one evening
- Multi-channel option available with addition of CD-2 crystal deck
- Will easily drive our 15 and 25 watt amplifiers to full output

Order TX-144B or TX-220B at $29.95 each plus shipping and sales tax if applicable.

TX-432 . . . $39.95

RECEIVER KITS



RX-50C, RX-144C, RX-220C and RX-432C RECEIVER KITS

RX-50C	30-55 MHz	$59.95
RX-144C	140-170 MHz	$69.95
RX-220C	210-240 MHz	$69.95
RX-432C	420-470 MHz	$79.95

*RXCF – 70db filter add $8.50 to above.

INEXPENSIVE AND UNIQUE MODULAR CONCEPT

- Performance equal to commercial equipment
- Monitor receivers
- Repeaters: using our transmitter, 15 or 25 watt amplifier and COR modules
- 10 channel auto-scan receivers: using our SC-3 scanner kit and CD-1 crystal deck
- Transceivers using our transmitter module
- Size: 4" x 6" – *RX-432C is 4" x 6-1/2"

All Receiver kits are dual conversion with squelch and COR output.

RX-144C SPECIFICATIONS: SENSITIVITY .3uV for 20db quieting. SQUELCH THRESHOLD .2uV. AUDIO OUTPUT 2 watts. STABILITY better than ±.002. IMAGE REJECTION 60db. SPURIOUS REJECTION greater than 60db. IF REJECTION 80db. FIRST IF 10.7 MHz. SECOND IF 455 KHz. BANDWIDTH 15 KHz at 3db, 60 KHz at 40db (70 KHz with optional 4 pole filter). CRYSTAL 45 MHz parallel at 20pf (HC/25U holder).

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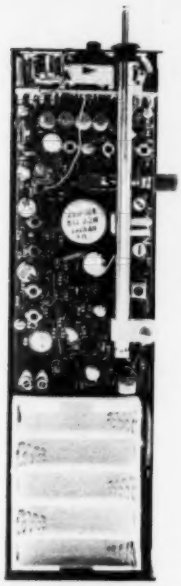
WALKIE-TALKIE KIT



- 2 Watts minimum
- 4 Channels
- .35uV for 20dB of quieting
- Low battery drain . . . less than 10 Ma
- Now you can build a commercial quality walkie talkie at home at half the price.
- Designed with the ham in mind. Average assembly time, just 10 hours.
- Small and handy, yet large enough to be assembled with conventional tools.
- Attractive, scratch resistant textured finish.
- Lightweight, sturdy aluminum case.

- Black textured case 1-1/2 x 2-1/2 x 9-1/4
- All tunable coils are prewound
- Transceiver is on one G-10 predrilled board
- Parts layout silk-screened on boards for easy construction
- Crystal deck is separate predrilled board
- Weight less batteries – approximately 15 oz.
- Battery-case is AA size – accepts alkaline or nicad
- External battery charging/power supply jack furnished
- 1 dual gate mosfet 2 I.C.'s 15 transistors 7 diodes
- Antenna – collapsible 17" whip
- Covers any 2 Mhz segment between 140 and 170 Mhz
- Plenty of room in case for add ons (PL and tone)

HT-144 RECEIVER SPECIFICATIONS: SENSITIVITY better than .35uV for 20db quieting. SQUELCH THRESHOLD better than .25uV. STABILITY .002 typical (depends on crystal). ADJACENT CHANNEL REJECTION 60 db. SPURIOUS RESPONSES down 70db. FIRST IF 10.7 Mhz SECOND IF 455 Khz. FILTER 4 pole monolithic 10.7 Mhz crystal. DISCRIMINATOR pretuned ceramic 455 Khz. BANDWIDTH 15 Khz at 3db points. CRYSTAL 45 Mhz parallel at 20pf. CRYSTAL FORMULA receive frequency minus 10.7 divided by 3. AUDIO OUTPUT .5w typical. CURRENT DRAIN 10 ma squelched, 100 ma on voice peaks.

HT-144 TRANSMITTER SPECIFICATIONS: OUTPUT 2 watts miniumum. 3 DB BANDWIDTH 2 Mhz typical. STABILITY .002 typical (depends on crystal). SPURIOUS outputs down 30db or better. MODULATION true FM with varactor in crystal circuit. NETTING separate trimmers for each channel. DEVIATION adjustable to 7 Khz. AUDIO limiter and active low pass filter. MICROPHONE speaker type. CRYSTAL 18 Mhz parallel at 20 pf. MULTIPLICATION FACTOR frequency times 8. CURRENT DRAIN 500 ma typical.

ACCESSORIES: "Rubber Duckie" Antenna (Including BNC Connectors and Adaptor) $9.95
Nicad Battery Charger 4.95
Sealed 12V Nicad Battery Pack 29.95

KIT . . . Only $129.95 – includes crystals for 52 simplex (less batteries).

Please include $1.00 for shipping and handling. N.Y. State residents add sales tax.

PRICES & SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE

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REPEATERS

MODEL RPT-144 • MODEL RPT-220 • MODEL RPT-432

Why make do with a converted Mark II Gizwachi when you can get a complete repeater designed for Hams by Hams, AT A PRICE YOU CAN AFFORD. The RPT-144, RPT-220 and RPT-432 are self-contained – all solid state machines. Conservatively rated, high quality, components deliver EXCELLENT RELIABILITY. Careful consideration has been given to both interfacing and control flexibility.

RPT-144, RPT-220 and RPT-432

The Model RPT-144, RPT-220 and RPT-432 are supplied as complete repeater systems. The receiver transmitter, control circuitry, C.W. Identifier & 117 Volt AC power supply are all contained on a standard relay-rack panel and chassis unit. For most installations a user supplies AC power and suitable antennas with 50 OHM coaxial feed (PL 259 fittings). External connections for autopatch, tone control etc. are provided. Built-in identifier programmed with up to 160 bits. Automatic emergency battery power changeover capability.

MODEL	FREQUENCY RANGE
RPT-144	140MHz - 170MHz
RPT-220	210MHz - 240MHz
RPT-432	420MHz - 470MHz

CIRCUITRY: All Solid State
NUMBER OF CHANNELS: 1
INPUT VOLTAGE: 117 ± 10 volts 50-60Hz
CIRCUIT PROTECTION: 5 AMP Fuse
DIMENSIONS: Panel – Standard 19" x 7" Rack Depth behind panel 11-3/4"
WEIGHT: 21 pounds
SHIPPING WEIGHT: 24 pounds

TRANSMITTER

POWER OUTPUT: 15 Watts (into 50 OHMS)
(RPT-432 output 10 Watts)
a) All harmonics down 40DB
b) Other spurious outputs down by more than 50DB
MODULATION: Audio processing with pre-clipping pre-emphasis
a) Audio clipping: 6DB per octave roll off above 3KHz
b) Deviation: Adjustable up to 7KHz. Factory preset to 5KHz
c) True FM
FREQUENCY STABILITY: Typically .001% crystals (supplied only in wired and tested units)

RPT-432 kit $399.95
Factory wired and tested $649.95

RECEIVER

SENSITIVITY: .3uv for 20DB quieting (.5uv 220 and 432)
Squelch sensitivity (threshold) .25uv (.35uv 220 and 432)
SQUELCH TYPE: Noise
MODULATION ACCEPTANCE bandwidth: ± 7-1/2KHz
SELECTIVITY: 70DB adjacent channel rejection (30KHz)
AUDIO POWER OUTPUT: 2 Watts (minimum) to panel speaker
AUDIO RESPONSE: Meets EIA specifications
FREQUENCY STABILITY: Depends on crystal installed. .001 with commercial spec. crystals (supplied only in wired and tested units)

RPT-144 or 220 kit $364.95
Factory wired and tested $595.95

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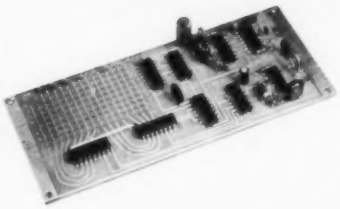
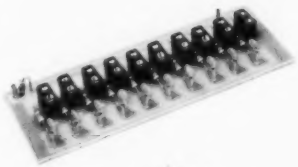
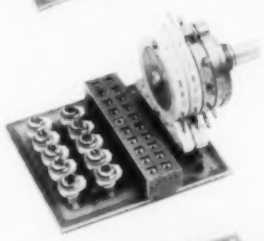
50-144-220-432 MHz RECEIVERS



CWID – Provides a fully field programmable identifier with variable pitch and speed. Up to 159 bits may be used to provide automatic Repeater I.D., automatic transmission of contest calls, R.T.T.Y. identification or any other application requiring a repeatable CW transmission. Price: $39.95 kit
59.95 programmed, wired & tested

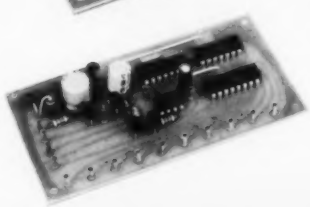


CD-1 – A ten channel receive crystal deck which utilizes diode switching to select the crystal position required. This module can be used to expand your present single channel receiver to multichannel capability. Price: $6.95 kit



CD2 – Designed to provide multichannel operation for our TX series of transmitters. It features an extra set of contacts that may be wired to the CD-1 crystal deck for 10 channel transceive capability. Includes board, crystal sockets, netting trimmers and switch. Price: $14.95 kit

10 CHANNEL SCANNING



SC3 – Capable of scanning up to 10 channels. Scan delay allows both sides of a conversation to be monitored without the scan starting each time the carrier drops. The priority feature allows the user to program the scanner to return to his favorite channel whenever it is active. Price: $19.95 kit

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ORDER FORM

Item	Part No.	Description	Price	Extension

Name _____ Total _____
Address _____ Shipping _____
City _____ NYS Resident Sales Tax _____
State _____ Zip _____ Total Enclosed _____
Master Charge No. _____
BankAmericard No. _____

SHIPPING INFORMATION: All shipments are F.O.B. Binghamton, N.Y. 13902. Shipments will be made by the most convenient method. Please include sufficient funds to cover shipping and handling. Figure shipping charges on a minimum weight of 2 pounds per unit with the exception of the following: PS-12C – 13 lbs., PS-24C – 25 lbs., Repeaters – 25 lbs., PA140/30 and PA140/10 ship wgt. 4 lbs.

*DPLX-144 and DPLX-220 are shipped freight collect.

TERMS: C.O.D., cash or check with order. We also accept BankAmericard and Master Charge.
CLAIMS: Notify VHF *and* the carrier of damage within seven (7) days of receipt of shipment.
RETURNS: Obtain authorization from VHF before returning *any* merchandise.
PRICES AND SPECIFICATIONS: Subject to change without notice.

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	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	31			

JANUARY '76

SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	31

January 19-24: Possible aurora.

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ARGENTINA	7	7	7	7	7	7	14	14	14A	14A	14A	14
AUSTRALIA	14	7B	7B	7B	7	7	3B	7	14	14	14	14
CANAL ZONE	7	7	7	7	7	3A	7A	14	21	21	14	14
ENGLAND	3A	7	7	3	7	7	7A	14	14A	14	7	3A
HAWAII	14	7B	7	3	7	7	3	3	7B	14	14A	14A
INDIA	3B	7	7B	7B	7B	7B	7B	14	7B	7B	7B	7
JAPAN	14B	7B	7B	7	7	3	3	7	7B	7B	7B	14B
MEXICO	14	7	7	7	7	7	7	14	14	14A	14A	14
PHILIPPINES	7A	7B	7B	3B	7B	3B	3	7	7	7B	3B	7
PUERTO RICO	7	7	3	3	3	3	7A	14	14	14	14	14
SOUTH AFRICA	7	7	7	7	7B	7B	14	14A	21	21	14	14
U. S. S. R.	7	7	3	3	7	7B	7B	14	14	7B	3A	3A
WEST COAST	14	7	7	3A	7	7	7	7A	14	14A	14A	14

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ALASKA	14	7	7	3	3	3	3	3	7	14	14	14
ARGENTINA	14	7	7	7	7	7	7	14	14	14A	14A	14
AUSTRALIA	21	7B	7B	7B	7	7	3B	7	14	14	14	14
CANAL ZONE	14	7	7	7	7	7	7	14	21	21	14	14
ENGLAND	3	7	7	3	7	7	14	14	14	7B	3B	
HAWAII	14	7	7	3	3	7	3	3	7	14	14A	14A
INDIA	7A	7A	7B	3B	7B	7B	3	7	7	7B	7B	7A
JAPAN	14	7B	7B	3B	3	3	3	3	7	7B	7B	14
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PUERTO RICO	7A	7	7	7	7	7	7	14	14A	14A	14	14
SOUTH AFRICA	7A	7	7	7	7B	7B	7B	14	14A	14A	14	14
U. S. S. R.	7	7	3	3	7	7	7B	14	7B	7B	7B	3A

WESTERN UNITED STATES TO:

ALASKA	14	7	7	3	3	3	3	3	7	7A	14	14
ARGENTINA	14	7	7	7	7	7	7	14	14	14	14A	14A
AUSTRALIA	14A	14	14	7B	7	7	7	3B	7	14	14	14
CANAL ZONE	14	7	7	7	7	7	7	3A	14	14	21	21
ENGLAND	3B	7	7	3	7	7	7	3B	7B	14	14B	7B
HAWAII	14A	14	7	7	7	7	7	7	3	7	14	21
INDIA	7B	14B	7B	3B	3B	7B	3	3	7	7	7B	3B
JAPAN	14A	14	7B	3	3	3	3	3	7	7	7B	14
MEXICO	14	7	7	3	7	7	7	3	7	14	14A	14A
PHILIPPINES	14A	14	7B	3B	3B	3	3	3	7	7	7B	14
PUERTO RICO	14	7	7	3	7	7	7	7	14	14	14A	14A
SOUTH AFRICA	14	7	7	3	7	7	7B	7B	7B	14	14A	14
U. S. S. R.	7B	7	3	3	3	7	3B	3B	7	7B	7B	7B
EAST COAST	14	7	7	3A	7	7	7	7A	14	14A	14A	14

EASTERN UNITED STATES TO:

GMT:	00	02	04	06	08	10	12	14	16	18	20	22
ALASKA	7	7	7	3	3	3	3	3	7	7A	14	14
ARGENTINA	7	7B	7B	7	7	7	14	14	14	14	14A	14A
AUSTRALIA	14	14	7B	3B	7	7	3B	7	14	14	14	14
CANAL ZONE	7	7	7	7	7	7	7	14	14A	14A	14	14
ENGLAND	3A	3	3	3	3	3	7	14	14A	14	7	7
HAWAII	14	7B	7	3	3	3	3	3	7B	14	14A	14
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MEXICO	14	7	7	7	7	7	7	14	14	14	14A	14
PHILIPPINES	7A	7B	3B	3B	3B	3	3	7	7	7B	3B	3B
PUERTO RICO	7	3	3	3	3	3	7	14	14	14	14	14
SOUTH AFRICA	7	7	3	3A	3	7B	14	14A	14A	14	14	14
U. S. S. R.	3	3	3	3	3	3B	7	14	7A	7B	3B	3
WEST COAST	14	7	7	3	7	7	3	7	14	14A	14A	14

CENTRAL UNITED STATES TO:

ALASKA	14	7	7	3	3	3	3	3	7	7A	14	14
ARGENTINA	14	7B	7B	7	7	7	7B	14	14	14	14A	14A
AUSTRALIA	14	14	7B	3B	7	7	3B	7	14	14	14	14
CANAL ZONE	14	7	7	7	7	7	7	14	14A	14A	14A	14A
ENGLAND	3	3	3	3	3	3	3A	14	14	14	7B	7
HAWAII	14	7B	7	3	3	3	3	3	7	14	14A	14A
INDIA	3	7	3B	3B	3B	3B	3	7	7A	7	3B	3B
JAPAN	14	7B	7B	3	3	3	3	3	3	3B	7	14
MEXICO	7A	7	3	3	3	3	3	7	14	14	14	14
PHILIPPINES	14	7B	3B	3B	3B	3	3	3	7	7	3B	7
PUERTO RICO	14	7	7	7	7	3	7	14	14	14A	14A	14
SOUTH AFRICA	7A	7	3	3	3B	3B	7B	14	14A	14	14	14
U. S. S. R.	3	3	3	3	3	3B	3B	7A	7A	7B	3B	3B

WESTERN UNITED STATES TO:

ALASKA	14	7	7	3	3	3	3	3	7	7A	14	14
ARGENTINA	14	7B	7B	7	7	7	3B	7B	14	14	14	14A
AUSTRALIA	14	14A	14	7B	7	3B	3B	3B	7	7A	14	14
CANAL ZONE	14	7	7	3	7	7	3	7A	14	14A	14A	14A
ENGLAND	3B	3	3	3	7	3	3B	7B	14	14	7B	7B
HAWAII	14A	14	7A	7	3	3	3A	3	7	14	21	14A
INDIA	3B	14	3B	3B	3B	3B	3B	3	7	7	3B	3B
JAPAN	14	14	7B	3	3	3	3	3	3A	3A	7	14
MEXICO	14	7	3	3	3	3	3	7	14	14	14A	14
PHILIPPINES	14	14	7B	3B	3B	3	3	3	7	7	7B	14
PUERTO RICO	14	7	7	3	7	3	3	7A	14	14A	14A	14
SOUTH AFRICA	14	7	3	3	3	3	3B	7B	14A	14A	14	14
U. S. S. R.	3	3	3	3	3	3B	3B	3	7A	7	3B	3B
EAST COAST	14	7	7	3	7	7	3	7	14	14A	14A	14

A = Next higher frequency may be useful also.
B = Difficult circuit this period.

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